February 1928 Entomological Series Vol. X, No. 6

LIBRARY, ROYAL BOTANIC GARDENS, KEW
CANCELLED

Memoirs of the Department of Agriculture in India

Studies on Platyedra gossypiella, Saunders, (Pink-Bollworm) in the Punjab

PART I

BY

SOHAN SINGH BINDRA, M.Sc.
Assistant Cotton Entomologist, Agricultural College, Lyallpur

AGRICULTURAL RESEARCH INSTITUTE, PUSA

Calcutta: Government of India
Central Publication Branch
1928

Price Re. 1-4 or 2s. 3d.

ROYAL BOTANIC GARDENS
c. 3·9·28.
KEW

EDITED BY

The Council of the Pusa Agricultural Research Institute which is not, as a body, responsible for the opinions expressed in the Memoir.

February 1928 Entomological Series Vol. X, No. 6

Memoirs of the Department of Agriculture in India

Studies on Platyedra gossypiella, Saunders, (Pink-Bollworm) in the Punjab

PART I

BY

SOHAN SINGH BINDRA, M.Sc.

Assistant Cotton Entomologist, Agricultural College, Lyallpur

AGRICULTURAL RESEARCH INSTITUTE, PUSA

Calcutta: Government of India
Central Publication Branch
1928

Government of India Publications are obtainable from the Government of India Central Publication Branch, 3, Government Place, West, Calcutta, and from the following Agents :—

EUROPE.

OFFICE OF THE HIGH COMMISSIONER FOR INDIA,
42, GROSVENOR GARDENS, LONDON, S.W. 1.
And at all Booksellers.

INDIA AND CEYLON.

Provincial Book Depôts:

MADRAS :—Office of the Superintendent, Government Press, Mount Road, Madras.
BOMBAY :—Superintendent, Government Book Depôt, Town Hall, Bombay.
SIND :—Library attached to the Office of the Commissioner in Sind, Karachi.
BENGAL :—Office of the Bengal Secretariat Book Depôt, Writers' Buildings, Room No. 1, Ground Floor Calcutta.
UNITED PROVINCES OF AGRA AND OUDH :—Office of the Superintendent of Government Press, United Provinces of Agra and Oudh, Allahabad.
PUNJAB :—Office of the Superintendent, Government Printing, Punjab, Lahore.
BURMA :—Office of the Superintendent, Government Printing, Burma, Rangoon.
CENTRAL PROVINCES AND BERAR :—Superintendent, Government Printing, Central Provinces, Nagpur.
ASSAM :—Office of the Superintendent, Assam Secretariat Press, Shillong.
BIHAR AND ORISSA :—Office of the Superintendent, Government Printing, Bihar and Orissa, P. O. Gulzarbagh, Patna.
COORG :—Office of the Chief Commissioner of Coorg, Bangalore.
NORTH-WEST FRONTIER PROVINCE :—Office of the Manager, Government Printing and Stationery, Peshawar.

Thacker, Spink & Co., Calcutta and Simla.
W. Newman & Co., Ltd., Calcutta.
R. Cambray & Co., Calcutta.
S. K. Lahiri & Co., Calcutta.
The Indian School Supply Depôt, 309, Bow Bazar Street, Calcutta, and 226, Nawabpur, Dacca.
Butterworth & Co. (India), Ltd., Calcutta.
Rai M. C. Sarcar Bahadur & Sons, 90-2A, Harrison Road, Calcutta.
Standard Literature Company, Limited, Calcutta.
Association Press, Calcutta.
Chukervertty, Chatterjee & Co., Ltd., 13, College Square, Calcutta.
The Book Company, Calcutta.
James Murray & Co., 12, Government Place, Calcutta. (For Meteorological publications only.)
Ray Choudhury & Co., 68-5, Asutosh Mukherji Road, Calcutta.
The Oriental Publishing House, 34, Cornwallis Street, Calcutta.
Scientific Publishing Co., 9, Taltolla Lane, Calcutta.
B. C. Basak, Esq., Proprietor, Albert Library, Dacca.
Mitra Brothers, Rajshahi.
Higginbothams, Madras.
P. R. Rama Iyer & Co., Madras.
Rochouse and Sons, Madras.
G. A. Natesan & Co., Publishers, George Town, Madras.
Theosophical Publishing House, Adyar, Madras.
Bright & Co., Trivandrum.
The Booklover's Resort, Taikad, Trivandrum, South India.
E. M. Gopalakrishna Kone, Pudumandapam, Madura.
Vijapur & Co., Vizagapatam.
Thacker & Co., Ltd., Bombay.
D. B. Taraporevala, Sons & Co., Bombay.
Sunder Pandurang, Bombay.
Ram Chandra Govind & Sons, Kalbadevi Road, Bombay.
N. M. Tripathi & Co., Booksellers, Princes Street, Kalbadevi Road, Bombay.
Proprietor, New Kitabkhana, Poona.
The Manager, Oriental Book Supplying Agency, 15, Shukrawar, Poona City.
R. S. Gondhalekar's Book Depôt, Publisher and Bookseller, Budhwar Chawk, Poona City.
Managing Director, Co-operative Bookstall, Booksellers and Publishers, Poona City.
Rama Krishna Bros., Opposite Visrambag, Poona City.
Mangaldas & Sons, Booksellers and Publishers, Bhaga Talao, Surat.
Mrs. Radhabai Atmaram Sagoon, Kalbadevi Road, Bombay.
A. H. Wheeler & Co., Allahabad, Calcutta and Bombay.
R. B. Umadikar & Co., the Bharat Book Depot, Dharwar.
The Standard Bookstall, Karachi, Quetta, Delhi, Murree and Rawalpindi.
The Karachi Book Depot, Elphinstone Street, Camp, Karachi.
The Standard Bookstall, Quetta.
U. P. Malhotra & Co., Quetta.
J. Ray & Sons, 43, K. & L. Edwardes Road, Rawalpindi and Murree.
The Standard Book Depôt, Lahore, Nainital, Mussoorie, Dalhousie, Ambala Cantonment and Delhi.
N. B. Mathur, Supdt., Nazir Kanun Hind Press, Allahabad.
The North India Christian Tract and Book Society, 18, Clive Road, Allahabad.
Ram Dayal Agarwala, 184, Katra, Allahabad.
Manager, Newal Kishore Press, Lucknow.
The Upper India Publishing House, Ltd., 41, Aminabad Park, Lucknow.
Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore and Allahabad.
Rama Krishna & Sons, Booksellers, Anarkali, Lahore.
Puri Brothers, Booksellers and Publishers, Katcheri Road, Lahore.
The Tilak School Bookshop, Lahore.
The Standard Bookstall, Lahore.
The Principal, Sanskrit Book Depôt, Saidmitha Street, Lahore.
The Punjab Religious Book Society, Lahore.
Manager of the Imperial Book Depôt, 63, Chandney Chawk Street, Delhi.
Oxford Book and Stationery Company, Delhi.
Supdt., American Baptist Mission Press, Rangoon.
Proprietor, Rangoon Times Press, Rangoon.
The Modern Publishing House, Ltd., 30, Phayre Street, Rangoon.
Burma Book Club, Ltd., Rangoon.
Manager, the "Hitavada," Nagpur.
Bhisey Brothers, Booksellers and Stationers, Sitabaldi, Nagpur.
S. C. Talukdar, Proprietor, Students & Co., Cooch Behar.
The Manager, Ceylon Observer, Colombo.
The Manager, The Indian Book Shop, Benares City.
The Srivilliputtur Co-operative Trading Union, Ltd., Srivilliputtur (Satur S. I. R.).
The Students' Emporium, Patna.
Raghunath Prasad & Sons, Patna City.
Dandekar Brothers, Indore City.
The Hyderabad Book Depot, Chaderghat, Hyderabad Deccan).

PREFACE

The present investigation was undertaken at the Entomological Laboratory, Punjab Agricultural College, Lyallpur, and was conducted during the tenure of a research studentship (16th September 1923 to 3rd May 1926) awarded by the Indian Central Cotton Committee, Bombay. The cost of cotton bolls, menial labour, apparatus, etc., was borne by the Department of Agriculture, Punjab.

The investigation was carried out under the guidance of Mr. M. Afzal Husain, Entomologist to Government, Punjab, to whom I offer my sincere thanks for constant help and assistance in writing this paper. I must also express my gratitude to the Punjab Department of Agriculture for all the help given and facilities afforded to me in the conduct of my investigation.

SOHAN SINGH BINDRA

CONTENTS.

	PAGE
Introduction	167
Material	168
Variation in samples	169
I. Status and distribution	*ib.*
Regional distribution of Pink-Bollworm	170
II. Seasonal history during cotton season in South-eastern Punjab	172
Progress of Pink-Bollworm attack	*ib.*
Progress of Spotted Bollworm attack and its relation with that of Pink-Bollworm	173
Multiple infestation of Pink-Bollworm	175
Presence of Pink-Bollworm in different pickings of *kapas*	176
III. Resting stage of Long-cycle caterpillars and Emergence of Long-cycle moths	177
Resting stage of Long-cycle caterpillars	*ib.*
Pink-Bollworm resting in open bolls	178
Emergence of Long-cycle moths from open bolls	179
Emergence of Long-cycle moths from green bolls and proportion of Short and Long-cycle caterpillars present in green bolls collected at various dates	182
Distinction between real and apparent damage	183
Financial loss to the cotton crop	184
Summary	*ib.*

ILLUSTRATIONS.

	Facing page.
Plate XXVIII.—Emergence of long-cycle moths from open bolls and green bolls	180
„ XXIX.—Emergence of long-cycle moths from open bolls of different pickings	181
„ XXX.—Emergence of long-cycle moths from lint-worms and seed worms	181
„ XXXI.—Presence of short and long-cycle moths in green bolls collected at various dates	183

STUDIES OF *PLATYEDRA GOSSYPIELLA*, SAUNDERS, (PINK-BOLLWORM) IN THE PUNJAB.

PART I

BY

SOHAN SINGH BINDRA, M. Sc.,

Assistant Cotton Entomologist, Agricultural College, Lyallpur.

(Received for publication on 4th July 1927.)

Introduction.

The first authenticated record of the occurrence of *Platyedra gossypiella*, Saund., in the Punjab dates back to the year 1894, when two specimens were sent by the Director of Land Records and Agriculture, Punjab, to Merton, with the note—'Cotton boll moths reared from caterpillars from Lahore.' These specimens were identified as *Gelechia gossypiella*, Saund.[1]

In 1905 the ravages of the bollworms were responsible for a complete failure of cotton crop in the Central and South-western Punjab [2], and Lefroy, the then Imperial Entomologist, was deputed to investigate the problem. He arrived at the conclusion that the pests responsible for the disaster were Spotted Bollworms (caterpillars of *Earias insulana*, Boisd., and *Earias fabia*, Stoll.) and that the Pink-Bollworm (a caterpillar of *Platyedra gossypiella*, Saund.) occurred only in very small numbers and did not contribute to the losses.[3] The result of this report was that, while investigations were started on Spotted Bollworms, no attention was paid to the study of Pink-Bollworm.

In 1917 Bainbrigge Fletcher[4] drew attention to the fact that *Gelechia gossypiella*, Saund., occurs throughout the plains of India, Burma and Ceylon as a pest of cotton, serious in many localities, especially so in the United Provinces, Punjab and North-west Frontier Province. In 1922 it was discovered by the Entomological Section, Punjab, that cottons in Sialkot and Ferozepore districts were badly attacked by *Platyedra gossypiella*, Saund.[5]

---

[1] Durrant, J. H Notes on Tineina bred from cotton bolls. *Bull. Ent., Res., Vol. III*, London, 1912, p. 205.

[2] Renouf, W. Note on the cotton failure on account of Bollworm ravages in the Central and South-west Punjab in 1905, and on the results of measures taken to prevent recurrence in 1906. *Bull. No 1, Dept. Agri. Punjab*, Lahore, 1907, p. 1.

[3] Lefroy, H. M. An Outbreak of cotton pests in the Punjab, 1905. *Bull. No. 2, Agri. Res. Inst., Pusa*, 1909, p. 3.

[4] *Rept. Proc. Ent. Meet., Pusa, 1917*, p. 111.

[5] *Rept. Dept. Agri., Punjab*, for the year ending June 1923, Part II, Vol. II, Lahore, 1924, p. 181.

On the appointment (in 1923) of the present writer as the Indian Central Cotton Committee Scholar, detailed investigations on *Platyedra gossypiella*, Saund., were started in the Punjab. So far the work has been done along the following lines :—

(1) Status and distribution of *P. gossypiella*, Saund., in the Punjab.
(2) Seasonal history of *P. gossypiella*, Saund., during the cotton season in South-eastern Punjab.
(3) Resting stage of 'long-cycle' larvae and emergence of 'long-cycle' moths of *P. gossypiella*, Saund.

Material.

The material required for the investigation of the status and distribution of Pink-Bollworm in the Punjab was procured through the District Agricultural Assistants and Tahsildars and consisted of :—(1) Green bolls (*kharif* 1924), (2) *Kapas* (*kharif* 1923 and 1924) and (3) Cotton seeds (*kharif* 1923 and 1924). Samples of green bolls were procured from about one hundred different localities scattered all over the province, and in all about thirty-six thousand bolls were examined. Samples of *kapas* (seed-cotton) were obtained from about 250 different localities, and in all a quantity of about ten maunds of *kapas* was examined. Samples of ginned seeds were received from some of the important *mandies* and a number of ginning factories from all over the Punjab, and the quantity of seed examined was over one maund.

For the investigation of the seasonal history of Pink-Bollworm in the South-eastern Punjab, sixty-two localities were selected in the five districts, namely, Gurgaon, Rohtak, Hissar, Karnal and Ferozepore, and a fortnightly supply of 100 green bolls was procured throughout the two succeeding cotton seasons, *i.e.*, August to December 1924 and 1925. The instructions given to the collectors were :—

(1) that bolls should be collected from the same, or, at the most, neighbouring fields ;
(2) that the collection should be made from as many different plants as possible, without paying any regard to the size of the bolls or to the fact whether the bolls were attacked or not.

On the whole, these instructions were properly carried out, except that very small bolls (bolls up to five days old) were wanting in the samples received. In all about fifty thousand bolls were examined, and during the busiest season five hundred bolls had to be examined daily.

The material for the investigation concerning the resting stage of 'long-cycle' caterpillars and emergence of 'long-cycle' moths of *P. gossypiella*, Saund. consisted of :—(1) about one thousand samples of *kapas*, each weighing about one lb. collected from different localities in the South-eastern Punjab, and (2) a weekly supply of about 250 green bolls received from September to December from about twenty stations in the South-eastern Punjab.

Variation in samples.

Before examining the figures tabulated and drawing inferences, it is advisable to ascertain the correctness of the samples examined. This was ascertained only in the case of green bolls, and to accomplish this, it was arranged to get material collected by a trained Entomological Assistant. One thousand bolls were collected in December: 600 from Ballabgarh (District Rohtak) and 400 from Ambala. The bolls were examined in batches of 50 each and the attack of Pink-Bollworm was ascertained. It was noticed that, in all the 20 batches of 50 bolls each, the deviation in attack was not more than 16 per cent. above and 12 per cent. below the average attack (Table No. I, column 7).

The results, arrived at from the examination of 20 lots of 50 bolls each, were then condensed into 10 batches of 100 bolls each, and in each batch the deviation in attack was ascertained. It was then seen that, when the lots of 100 bolls each were taken into consideration, the fluctuations in the range of attack were not so great, being only 12 per cent. above and 9 per cent. below the normal attack. It is thus evident that variation in the percentage of attack in samples of 100 bolls was $\frac{3}{4}$th of the variation in samples of 50 bolls. The accuracy is bound to be greater in samples larger than 100 bolls, but it is regretted that it has not been possible to ascertain this. According to Dr. Gough [1], however, the percentage of attacked bolls in any sample of 100 bolls taken at random may vary, from the average for the field or district, to the extent of ten above and twelve below. It is thus safe to conclude that variation in attack in any sample of 100 green bolls cannot be more than 12 per cent. above or below the average attack.

I. Status and distribution of *P. gossypiella*, Saund., in the Punjab.

The examination of green bolls of cotton, *kapas* and ginned cotton-seeds, carried out during the two successive seasons (1923 and 1924), has conclusively shown that the status of *P. gossypiella*, Saund., as a pest of cotton, varies in different parts of the province.

With the highest intensity in that part of the Punjab which adjoins the United Provinces, the attack continues with decreasing severity along the foot of the mountains and towards the central districts, and is at its lowest in the Canal colonies and the dry area further west. Thus, on the basis of the intensity of attack of this insect on cottons, the Punjab may be divided into five regions or zones. It is interesting to note that this division, based on the prevalence of Pink-Bollworm, agrees fairly closely with a division based on the meteorological data, such as temperature and rainfall. The details of the Entomological data are given in Tables Nos. II, III and IV, and in what follows an attempt is made to correlate them with climatic factors.

[1] Gough, L. H. The rate of increase of the Pink-Bollworm in green bolls in the period July to November, 1916. *Min. Agri. Egypt, Tech. and Sci. Serv. Bull. No. 13*, Cairo, p. 9.

Regional distribution of Pink-Bollworm.

(1) *The South-eastern zone* includes the Districts of Gurgaon, Rohtak, Karnal, Hissar, Ferozepore, Ludhiana and Jullundhar. On the east, this region is adjacent to Saharanpur and Muzaffarnagar Districts of the United Provinces, and to the west and south of it, is the sandy tract of Rajputana.

The rainfall during August and September—the period during which the first appreciable attack of Pink-Bollworm begins—is about 5 inches, and the normal maximum shade temperature during these months is 95·4°F. There are about 4½ lakh acres under cotton every year, *i.e.*, about 21 acres per square mile. It is an important cotton growing tract for the Indian varieties, the American varieties being practically absent except in the Ferozepore District. This region shows the highest attack of *P. gossypiella*, Saund.,—the maximum attack on green bolls reaches 67·7 per cent. and the average number of Pink-Bollworms found per 100 *tolas* of *kapas* of mixed pickings is 299. The percentage of seed damaged by Bollworms (especially the Pink-Bollworm) is 13·8, and the number of Pink-Bollworms calculated per 10,000 ginned seeds is 45.

(2) *The Eastern zone* includes the Districts of Ambala, Hoshiarpur, Kangra, Gurdaspur, Amritsar and Sialkot. (Simla District, which also lies in this region, is hilly and no cotton is grown there.) This region consists of mountainous and sub-montanous tracts and plains adjacent to these tracts. During August and September the rainfall is about 20 inches, and the normal maximum shade temperature during these months is 94·0°F. There are about 2¼ lakh acres under cotton every year, *i.e.*, about 12 acres per square mile. *Desi* cottons are chiefly cultivated, while American cottons are rarely seen. As regards the extent of damage, this region comes next to the South-eastern Punjab. The maximum attack on green bolls reaches 56·1 per cent. and the average number of Pink-Bollworms found per 100 *tolas* of *kapas* of mixed pickings is 175. The percentage of seed damaged by Bollworms (especially the Pink-Bollworm) is 5·4 and the number of Pink-Bollworms calculated per 10,000 ginned seeds is 32.

(3) *The Central zone* includes the Districts of Lahore, Gujranwala and Gujrat which occupy the central position in the province. During August and September the rainfall is about 8 inches, and the normal maximum shade temperature is 97·8°F. There are about 3¼ lakh acres under cotton every year, or on the average 43 acres per square mile. The maximum attack on green bolls reaches 41·9 per cent. and the average number of Pink-Bollworms found per 100 *tolas* of *kapas* of mixed pickings is 67. The percentage of seed damaged by Bollworms (especially the Pink-Bollworm) is 4·5, and the number of Pink-Bollworms calculated per 10,000 ginned seeds is 11.

(4) *The Northern zone* comprises the Districts of Jhelum, Rawalpindi and Campbellpore. Very little cotton is grown in this tract; about 40 thousand acres are put under cotton every year, *i.e.*, about 4 acres per square mile. American cottons are

still a rarity in this region. During August and September the rainfall is 12·6 inches, and the normal maximum shade temperature during these months is 93·7°F. The average number of Pink-Bollworms found per 100 *tolas* of *kapas* of mixed pickings is 32, the percentage of seed damaged by Bollworms is 2·5, and the number of Pink-Bollworms calculated per 10,000 ginned seeds is 7. The infestation is fairly uniform and slightly higher than that in the Western Punjab including the Colony areas.

(5) *The Western zone including the Colony areas* [1] comprises the Districts of Shahpur, Jhang, Lyallpur, Sheikhupura, Montgomery, Multan, Dera Ghazi Khan, Muzaffargarh and Mianwali. During August and September the rainfall is only 2·3 inches, and the normal maximum shade temperature is 99·6°F., the highest in the province. It is an important cotton growing tract of the province, and there are about 13 lakh acres under cotton every year, i.e., about 32 acres per square mile. *Desi* and American cottons are cultivated in the ratio of about 1 to 2. The maximum attack on green bolls does not exceed 5 per cent., and the average number of Pink-Bollworms found per 100 *tolas* of *kapas* of mixed pickings is only 11. The percentage of seed damaged by Bollworms (especially the Spotted-Bollworm) is 2·5 and the number of Pink-Bollworms calculated per 10,000 ginned seeds is 4.

A summary of the attack of Pink-Bollworm on cottons and the meteorological condition in the different zones of the Punjab is given below :—

Region	August and September		Percentage of green bolls attacked	No. of Pink-Bollworms found per 100 *tolas* of *kapas*	No. of Pink-Bollworms found per 10,000 ginned seeds	Remarks.
	Rainfall in inches	Average maximum temperature F.				
South-eastern . . .	5	95	67·7	299	45	
Eastern	20	94	56·1	175	32	
Central	8	98	41·9	67	11	
Northern	12	94	..	32	7	Very little cotton is grown.
Western including the Colony areas.	2	100	4·6	11	4	

The facts brought forward go to prove that although Pink-Bollworm has had free access to the 'Western Punjab including the Colony areas,' and more cotton is grown in this area than in the rest of the Punjab, thus providing—in so far as the food supply is concerned—the most favourable conditions for the distribution and propagation of *P. gossypiella*, Saund., yet the insect has not been able to attain such a prominence in this region as to be called a 'pest'. On the other hand, it appears to flourish all along the submontane tract and has firmly established

[1] Lower Bari Doab Canal Colony, Lower Jhelum Canal Colony, and Lower Chenab Canal Colony excluding portions of Gujranwala and Sheikhupura Districts.

itself as a ' major pest ' in the South-eastern Punjab. The temperature appears to be one of the chief controlling factors. It will be seen that all the Districts included in the zone ' Western Punjab including the Colony areas ' lie south-west of the isothermal line of 102°F. This is the average maximum temperature during June to September, while the absolute maximum, to which the insect is subjected, reaches 120°F. in June and 115°F. in July. On the other hand, the average maximum temperature during June to September in the South-eastern and Eastern Punjab is 95°F. and the absolute maximum does not exceed 110°F. These are the temperatures in shade ; the actual field temperatures are undoubtedly much higher. The fatal temperature for the resting larvae, as pointed out by Willcocks[1], is 50°C. (122°F.) to 55°C. (131°F.), which makes it evident that, just as in Southern Egypt, so in the Western Punjab including the Colony areas, the temperature in the fields during June and July will be too high for the caterpillars to survive, and therefore no moth will emerge during July and August.

It will not be out of place to mention that the excessive summer rainfall does not appear to exercise any check on Pink-Bollworm. It has been observed that even in a District like Kangra (Eastern Punjab), where the rainfall from June to September is above 50 inches, the pest flourishes, and as many as 192 Pink-Bollworms were found per 100 *tolas* of *kapas* of mixed pickings. (This figure is the average of 22 samples examined from 10 different localities in the District.)

II. Seasonal history of *P. gossypiella*, Saund., during cotton season in the South-eastern Punjab.

With a view to gain detailed information regarding the seasonal variation in the intensity of Bollworm attack in the South-eastern Punjab, an examination of green bolls was conducted during *kharif* 1924 and 1925. The results of this enquiry are presented in Table No. V. The data were collected separately for each of the twenty-three tahsils of the South-eastern Punjab and to get more uniform results, the records for different tahsils of a District have been combined and those for the different District put together to get results for the whole region. The figures of attack for the region, being based on fortnightly examinations of two to three thousand bolls, might be taken to represent a true condition of attack in the region as a whole.

Progress of Pink-Bollworm attack.

The progress of Pink-Bollworm attack has been recorded in four different ways :—(1) on bolls, (2) on loculi, (3) on seeds, and (4) the number of Pink-Bollworms found per 100 green bolls.

(1) *Attack on green bolls.* In Table No. V, column 4 shows the rate of increase of Pink-Bollworm during the season August to December. The study of these

[1] Willcocks, F. C. The insects and related pests of Egypt: Vol. I. The insect and related pests injurious to the cotton plant: Part I. The Pink Bollworm, 1916, Cairo, p. 162.

figures indicates that not more than 16 per cent. of the bolls were attacked by the end of September, but after the middle of October the progress of attack was very rapid until it reached its maximum (63 per cent.) towards the end of December.[1]

(2) *Attack on loculi of green bolls.* In Table No. V, column 7 gives the percentage of attack on the loculi in an average sample consisting of both the sound and attacked bolls. The study of these figures clearly indicates that attack on the loculi of green bolls followed the same general rule as was observed in the case of bolls, but the maximum attack did not exceed 42 per cent. It will not be out of place to mention that the number of loculi produced in an attacked boll is the same as that produced in a healthy boll, because the septa are formed at a very early stage. In Table No. V, column 5 gives the percentage of loculi damaged in the attacked bolls only, which will clearly indicate that the attack of Pink-Bollworm on green bolls is usually restricted to two loculi (59·4 to 68·9 per cent.), and the third loculus is invariably found to be sound. (Three is the normal number of loculi in a boll of *Desi* cotton.)

(3) *Attack on seeds in green bolls.* In Table No. V, column 8 gives the percentage of attack on the seeds in green bolls, and these figures show that there was a continuous rise of attack from August to December, as was noticed in the case of bolls and loculi though not to the same extent. Bolls in which all the seeds had been attacked were not uncommon, but usually not more than one-third (25·4 to 40·2 per cent.) of the seeds were lost, and the amount of absolute damage did not exceed 18·8 per cent.

The number of mature seeds produced in the sound bolls was invariably found to be higher than that produced in the attacked bolls, but the exact relationship between the number of seeds produced in the attacked and those in the sound bolls is a problem for future investigation.

(4) *Number of Pink-Bollworms per 100 bolls.* In Table No. V, column 12 gives the number of Pink-Bollworms found per 100 bolls. It will be seen that in August a large number of attacked bolls had each a single caterpillar in it, later on multiple infestation was commonly observed, and towards the end of the season, each attacked boll had, on an average, two caterpillars in it. Further information on the subject is given below (Page 175).

Progress of Spotted Bollworm attack and its relation to that of Pink-Bollworm.

Since 1905, when Lefroy investigated the causes of the failure of cotton crop in the Punjab, it has been generally believed that the Spotted Bollworm predomin-

[1] It may be pointed out that in arriving at these conclusions the total population of bolls present on the plants at a particular time has not been taken into consideration but only the percentage of attack is taken as a point for consideration. For further discussion reference may be made to page 175 below.

ated the Pink-Bollworm throughout the Punjab, but the present investigation has clearly shown that, except during certain abnormal years, the Pink-Bollworm is by far the most serious pest in many parts of the province. In Table No. V, column 9 gives the percentage of bolls attacked by Spotted Bollworm. The study of these figures would clearly indicate that during *kharif* 1924 and 1925, Spotted Bollworm was a minor pest in the South-eastern Punjab, the attack never exceeding 4 per cent., while in the case of Pink-Bollworm the maximum was 63 per cent. It may be pointed out that certain bolls attacked by Pink-Bollworm were also found to be attacked by Spotted Bollworm, but the percentage of bolls subjected to a combined attack was very small throughout the season and never exceeded 2 per cent. of the bolls examined. It cannot, however, be denied that Spotted Bollworms are capable of causing greater damage than Pink-Bollworms, because of their larger size and consequently greater appetite, and it was actually noticed that a boll attacked by Pink-Bollworm usually showed fewer damaged seeds than one attacked by Spotted Bollworm.

The attack of Spotted Bollworm varied between 1·4 to 3·9 per cent. ; the main period of its activity being before the middle of September, or in other words just before the cotton picking began.

It was also possible to record the number of bolls showing traces of Bollworm attack but containing no caterpillars, and the percentage of such bolls in the total number of bolls examined is given in Table No. V, column 10. These figures show that the number of bolls showing signs of Bollworm attack rose gradually from the beginning of August to the beginning of October, after which date the presence of such bolls in the fields began to decrease, till in December the number reached its minimum. The decrease in the number of bolls showing signs of Bollworm attack after the middle of October was probably due to the fact that some of these affected bolls opened and produced good cotton and therefore were not taken into consideration. The share of Spotted Bollworm in the damage caused to these bolls was undoubtedly greater in the beginning of the season, *i.e.*, before October, but later on the damage was mainly caused by Pink-Bollworm.

In Table No. V, column 11 gives the percentage of attacked bolls containing caterpillars or showing only signs of attack. These figures give an exact idea of the ravages done by Bollworms during *kharif* 1924 and 1925 in the South-eastern Punjab. It will be seen that towards the end of August, the attack reached 30 per cent. of the bolls examined, and towards the end of October it rose by another 20 per cent., till in the end of December 70 per cent. of the bolls were found attacked. It will not be out of place to mention that 70 per cent. attack on the bolls was the average figure obtained for the entire South-eastern region, and not for any particular locality ; at certain places, however, the maximum attack reached as high as 90 to 100 per cent. In this connection, two facts must be borne in mind. Firstly, the percentages of attacked bolls cannot be taken to denote the actual rise or fall in the number of insects in the field, unless something is known of the number of bolls

on the plants at the time of collection. Secondly, as the attacked bolls are not always rendered entirely unfit for the production of cotton, they are not necessarily an absolute loss to the cotton crop. In fact, on some bolls the attack may be so slight that a normal yield is obtained and in majority of cases some *kapas* is always produced. It may be further mentioned that, when the percentage of bolls attacked by Pink-Bollworm reached 62·9, the percentage of seeds attacked was only 18·8, but the relation between the percentage of green bolls attacked and the actual loss to the cotton crop remains to be investigated. The data regarding the bolls attacked would, on the other hand, give some idea of the number of insects present and indicate that the moths oviposit on a very large number of bolls.

As regards the progress of Bollworm attack in relation to the growth of cotton plant, it will be seen that with the fall in the population of green bolls during November and December, the number of attacked bolls also decreases. During this period increase in the number of insect also stops, because all the larvae seen in the fields after October belong to the long-cycle generation, a fact which will be elucidated further on. Evidently, it is during October that the damage done by Pink-Bollworm to cotton crop in the South-eastern Punjab is the heaviest.

Multiple infestation of Pink-Bollworm.

It is a well known fact that a cotton boll may harbour more than one Pink-Bollworm at a time, and such cases of multiple infestation were not uncommon in samples examined during the course of the present investigation. With a view to ascertain the variation in this number, an accurate record of the caterpillars found in each attacked boll was kept. It will be seen in Table No. VI that during August usually one Pink-Bollworm was found in each attacked boll, during September the number varied from one to five, and in October as many as six were found per attacked boll. During November the number of Pink-Bollworm infesting a green boll reached its maximum and in certain cases as many as ten caterpillars were recorded in an attacked boll, and in December this number showed a fall. Thus the number of Pink-Bollworms infesting an attacked boll varied with the bolling season of the cotton. According to the observations made by Willcocks[1] in Egypt, the multiple infestation reaches its maximum in October, *i.e.*, about a month earlier than in the South-eastern Punjab. From the study of Table No. VI it will also be seen that the average number of Pink-Bollworms infesting a boll continued to increase from the beginning of August to the beginning of December. Bolls containing more than five (six to ten) caterpillars each were found during November and December only.

[1] *Loc. cit.*, p. 42.

In the bolls attacked by Pink-Bollworm, the loculi were either (1) quite sound, (2) showed signs of attack or (3) actually contained Pink-Bollworm at the time of examination. In Table No. VII, column 6 shows the variation in the percentage of loculi of attacked bolls that showed signs of attack but contained no Pink-Bollworm. It will be seen that the number of such loculi rose gradually from the beginning of August (40 per cent.) to the beginning of October (50 per cent.), after which it steadily decreased till it reached its minimum in December (25 per cent.).

Most of the attacked loculi contained one Pink-Bollworm only, though a few had as many as five. The variation in the number of Pink-Bollworms found per attacked loculus is shown in columns 7 to 11 of Table No. VII from which it will be seen that the number of attacked loculi containing one Pink-Bollworm varied, during the cotton season, from 48 to 70 per cent., of those containing two Pink-Bollworms from 1 to 7 per cent., and those containing three to five Pink-Bollworms never exceeded 1 per cent. As a rule, the attacked loculi contained one Pink-Bollworm in August one to three in September and October, one to five in November and one to four in December.

In Table No. VII, columns 12 to 14 give information regarding the number of loculi damaged by Pink-Bollworm per boll. Each boll of *Desi* cotton shows three or four loculi, three being the usual number (about 80 per cent.). Cases of bolls with two or five loculi have also been recorded, but their number is quite negligible. As a rule, all the loculi of a boll are not attacked, the damage is usually restricted to two loculi, and the third loculus is invariably found to be sound. In the beginning of the season the number of bolls with two damaged loculi is small, but as the season progresses the number of such bolls increases.

Presence of Pink-Bollworm in different pickings of kapas.

The attack of Pink-Bollworm varies considerably in *kapas* of different pickings. With a view to gain information on this point, samples picked at various dates during *kharif* 1924 (Table No. VIII) were grouped into three pickings, early, middle and late, on a plan given below :—

Region	Cotton	Date of picking of *kapas*.			
		Early	Middle		Late
		Before	From	To	After
South-eastern, Eastern, Central, and Northern Punjab.	*Desi* . .	15th September	16th September	15th October	16th October
	American .	30th September	1st October	31st October	1st November
Western Punjab including the Colony areas.	*Desi* . .	22nd September	23rd September	22nd October	23rd October
	American .	15th October	16th October	15th November	16th November

The following is a summary of the number of Pink-Bollworms found per 100 *tolas* of *kapas* of different pickings :—

Region	Cotton	Early	Middle	Late
South-eastern	*Desi*	308	364	496
	American*	69	119	183
Eastern	*Desi*	169	151	211
	American	266	200	220
Central	*Desi*	73	72	124
	American	55	52	33
Northern	*Desi*	37	22	59
	American	4	0	55
Western Punjab including the Colony areas	*Desi*	10	11	14
	American	9	9	10

It will be seen that the attack of Pink-Bollworm was higher in the middle pickings of *kapas* than in early ones, and highest in samples of late pickings. This difference was more marked in areas where the attack of Pink-Bollworm was severe.

III. Resting stage of Long-cycle caterpillars and emergence of Long-cycle moths.

Resting stage of Long-cycle caterpillars.

Platyedra gossypiella, Saund., hibernates during the cold season in the caterpillar stage, and consequently the life-cycle of the last brood is much prolonged. This brood has, therefore, been designated the ' long-cycle brood' as distinct from the previous ' short-cycle broods'. The long-cycle becomes the more important because of the fact that, in countries where winter is severe, the infestation is carried from year to year by moths developing from the long-cycle caterpillars. There is no apparent anatomical feature or structural difference by which the long and short-cycle larvæ can be distinguished from each other ; it is only by the time taken by them to reach the adult stage that one can differentiate between the two. Very

* These samples were only procured from the Ferozepore District where the attack of Pink-Bollworm was least amongst all the Districts included in the South-eastern zone.

little was known regarding the emergence of long-cycle moths in the Punjab[1], and it was with a view to gain exact information of the bionomics of this brood that observations were started during the year 1924, and confirmed during 1925.

Pink-Bollworm resting in open bolls.

The most important problem in the control of Pink-Bollworm is the location of resting caterpillars during the interval between the last picking and sowing. At the end of the cotton season most of the larvæ find their way into the seed and lint of *kapas*, while a few remain in bolls which fall off from the plants, and some remain in bolls left on cotton sticks. The caterpillars in the seed and lint are of primary importance, not because the worms in picked cotton and ginned seeds would attract attention—being present in the marketable stuff, but mainly because the caterpillars resting in picked cotton and in ginned seed are the main sources of dispersion of the species and, as mentioned above, of the perpetuation of infestation. Consequently, in all control operations, it is, to a large extent, the long-cycle brood of caterpillars in picked cotton that is of importance.

In picked cotton Pink-Bollworms are found either (1) free in the lint, *viz.*, without cocoons, or (2) enclosed within fine silken cocoons spun in the lint, or (3) resting in chambers formed by the seeds in which the worms had been feeding. Most of the worms (92 to 95 per cent.) were found in the seeds, and only a few (5 to 8 per cent.) in the lint (Table No. IX).

The number of seeds forming the resting chamber varies from one to five in both the *Desi* and American cottons grown in the Punjab; Dr. Gough [2] found even six seeds utilized for this purpose in the Egyptian cottons. Table No. IX shows the number of caterpillars found resting in cotton lint and different forms of seed-chambers. In *Desi* cottons, 7·7 per cent. of the caterpillars were found resting in lint, and the other 92·3 per cent. utilized the protection afforded by seed-chambers (60·9 per cent. in 2-seeded, 19·3 per cent. in 3-seeded, 5·4 per cent. in 4-seeded, 4·9 per cent. in single-seeded and 1·8 per cent. in 5-seeded resting-chambers). In American cottons 5·4 per cent. of the caterpillars were found resting in lint, and the remaining 94·6 per cent. in seed-chambers (65·1 per cent. in 2-seeded, 16·6 per cent. in 3-seeded, 7·3 per cent. in single-seeded, and 4·3 per cent. in 4-seeded, and 1·2 per cent. in 5-seeded resting-chambers). It will be seen that the number of caterpillars resting in the lint of *Desi* cottons is slightly more (2·3 per cent.) than that in the lint of American cottons. Further, the number of caterpillars in 2-seeded chambers is greater in American than in *Desi* cottons (65·1 per cent. against 60·9 per cent.), while in 3 to 5-seeded chambers it is the other way about. It may be further added that inspite of the differences in the proportion of various types

[1] *Rept. Proc. Ent. Meet. Pusa*, 1917, p. 113.

[2] Gough, L. H. The Pink-Bollworm in Egypt. *Rept. Proc. Third Ent. Meet. Pusa*, Vol. II, 1920, p. 476.

of seed-chambers in the two kinds of cotton, a certain number of caterpillars in each case was found to have used approximately the same number of seeds in the formation of their resting-chambers as shown below :—

Type of resting-chamber	Percentage of Pink-Bollworms found resting in	
	Desi cottons	American cottons
1-seeded	4·9	7·3
2-seeded	60·9	65·1
3-seeded	19·3	16·6
4-seeded	5·4	4·3
5-seeded	1·8	1·2
No. of seeds used for 100 resting-chambers	215·2	210·5

Willcocks[1] has attempted to prove that the popular impression that the resting Pink-Bollworms are found only in Double seeds and not in Single seeds, or at all events only rarely in the latter, is erroneous, and has actually stated that in samples of cotton-seeds of some of the Egyptian varieties most of the resting caterpillars were found in single seeds (89·4 per cent.) and not in double seeds (10·6 per cent.). On the other hand, observations carried out by the writer clearly show that in the case of *Desi* and American varieties of cotton grown in the Punjab, the number of caterpillars found in single-seeded chambers is only 5 to 8 per cent. as against 92 to 95 per cent. in double-seeded chambers. No doubt, it is easier to detect the presence of a resting caterpillar in a double seed than in single one, but samples, on which the observations were made, were examined twice and no single-seeded chamber was missed out.

The seeds composing the resting-chamber vary a great deal in size and stage of development. It has been ascertained that when once the cotton is mature for picking, its seeds are never attacked by Pink-Bollworm. The stage of development of the seed when the attack actually begins remains to be investigated.

Each resting-chamber invariably contains a single caterpillar which lies curved like a hoop with its two ends together.

Emergence of Long-cycle moths from open bolls.

Samples of *kapas* of both *Desi* and American varieties of different pickings, *viz.*, early, middle and late of *kharif* 1923 and 1924, were procured from different localities

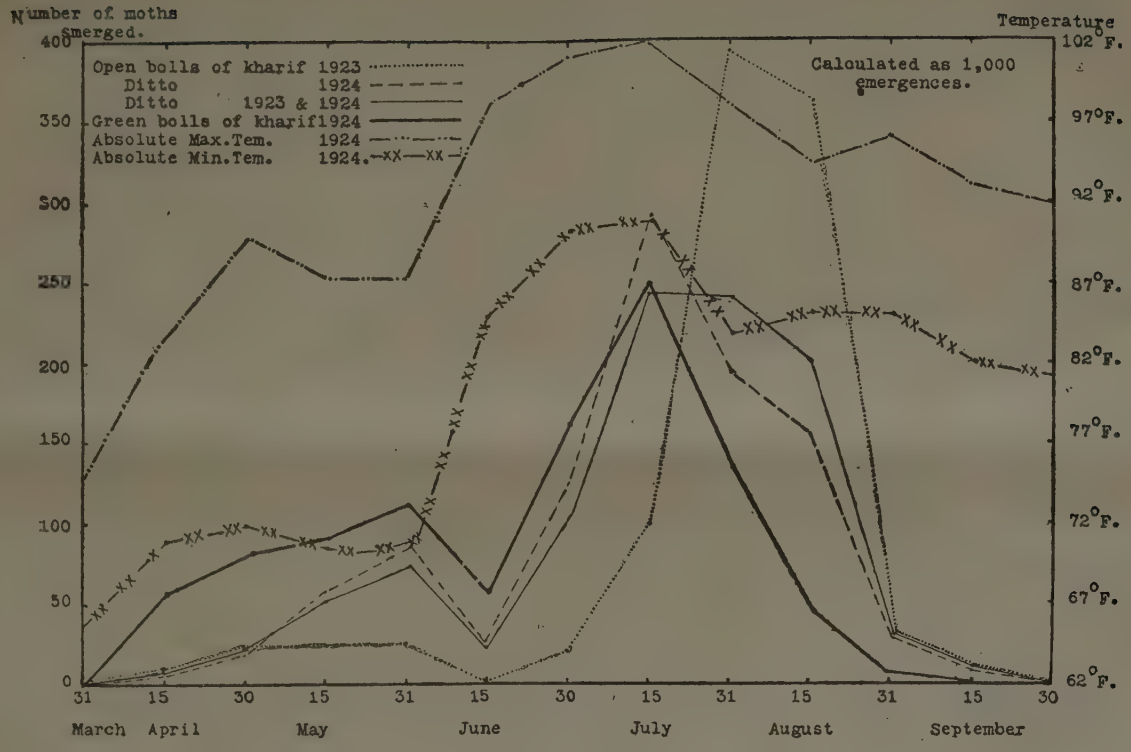
[1] *Loc. Cit.*, p. 139.

in the South-eastern Punjab. Each sample weighing 1 lb. was placed in an ordinary cage commonly used for breeding parasites. On one side of the box three small holes were made which were fitted with glass tubes. The moths attracted to diffused light in the glass tubes were daily captured, but for the sake of convenience, the daily records of emergences were added up into fortnightly figures which are given in Table No. X.

During the course of these experiments, it was noticed that the dates of emergence of moths differed with samples collected from different localities and that the different lots of resting caterpillars from the same locality behaved more or less alike. There was no emergence before the beginning of April and moths which emerged after 1st April were regarded as belonging to the long-cycle brood.

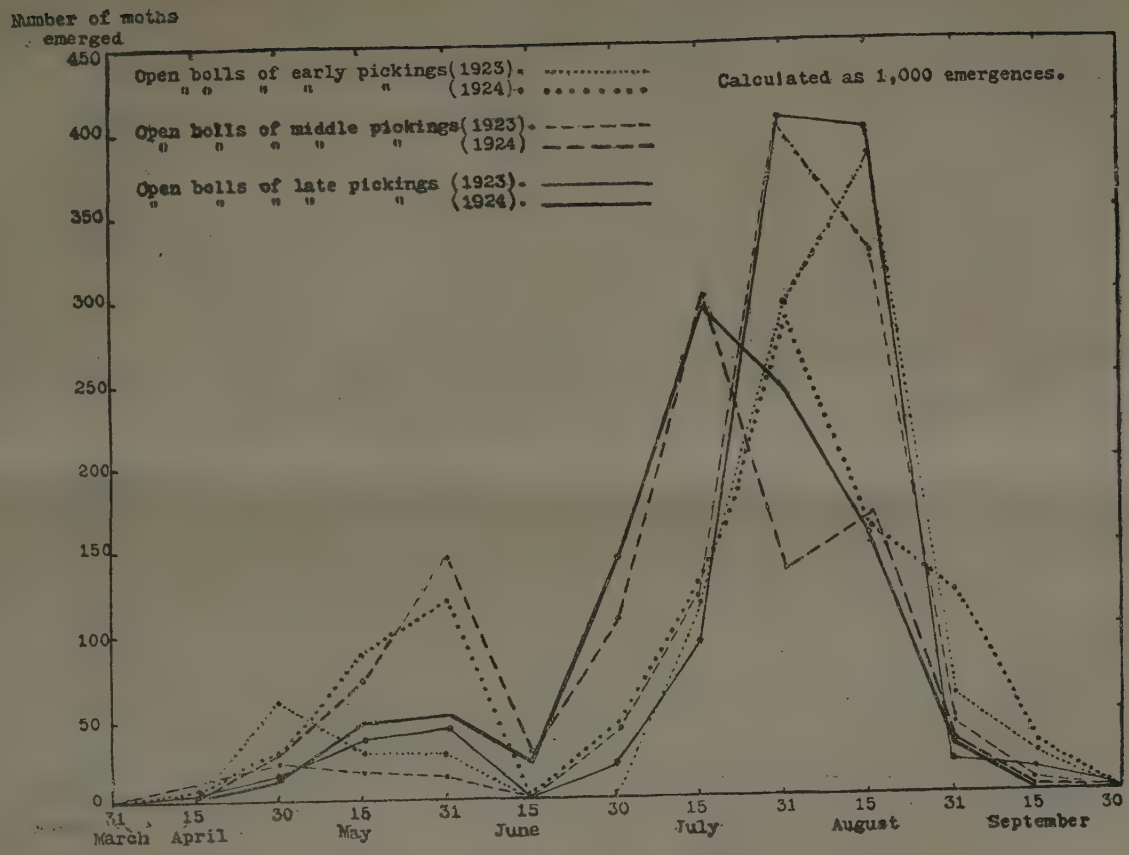
Table No. X shows the dates and the rate at which the emergence took place. In the first half of this table, the actual number of moths that emerged is given, and in the second half, the number has been calculated per 1,000 emergences so as to facilitate comparison. The emergence of moths began early in April (in 1924 the first moth emerged on 2nd April and in 1925 a day earlier), and continued to the middle of November (in 1924 the last moth emerged on 24th September and in 1925 seven weeks later). During 1925 the main emergence stopped towards the end of September as in 1924, except that two moths emerged very late, one in the beginning of October and the other towards the middle of November. It can thus be concluded that the emergence of long-cycle moths from caterpillars resting in *kapas* continues for a period of about eight months, *i.e.*, from April to November. The emergence starts in April and increases steadily until the end of May, after which the rate declines rapidly for a week or so. Towards the middle of June it rises again and reaches its maximum during July and the first half of August, after which there is again a sudden decline, but the emergence continues till the middle of November. During 1924 the maximum emergence was from 15th July to 15th August; in 1925 it was during July (Plate XXVIII).

It is not out of place to mention that at the time the caterpillars enter into the resting stage, they are at different stages of development; while some are full-fed and ready to pupate, others are not ready for this change. During the spring, *i.e.*, after March, as the temperature rises, the resting caterpillars begin to pupate and later on emerge as moths. It is, therefore, probable that the full-fed larvæ are the first to pupate and emerge as moths during April and May, while caterpillars, which are not full-grown at the time of their entering into the resting stage, probably begin to feed after the cold weather and complete their growth before pupating. It is very likely, therefore, that caterpillars with incomplete growth at the time of entering into the resting stage are not fit for pupation before June, and all emergences before that date are from full-fed caterpillars. From the middle of June to the end of July, the temperature is highest in the Punjab, so a greater number of caterpillars become full-fed by then and pupate, and consequently the emergence of moths is highest during July and August



Emergence of long-cycle moths from open bolls and green bolls.

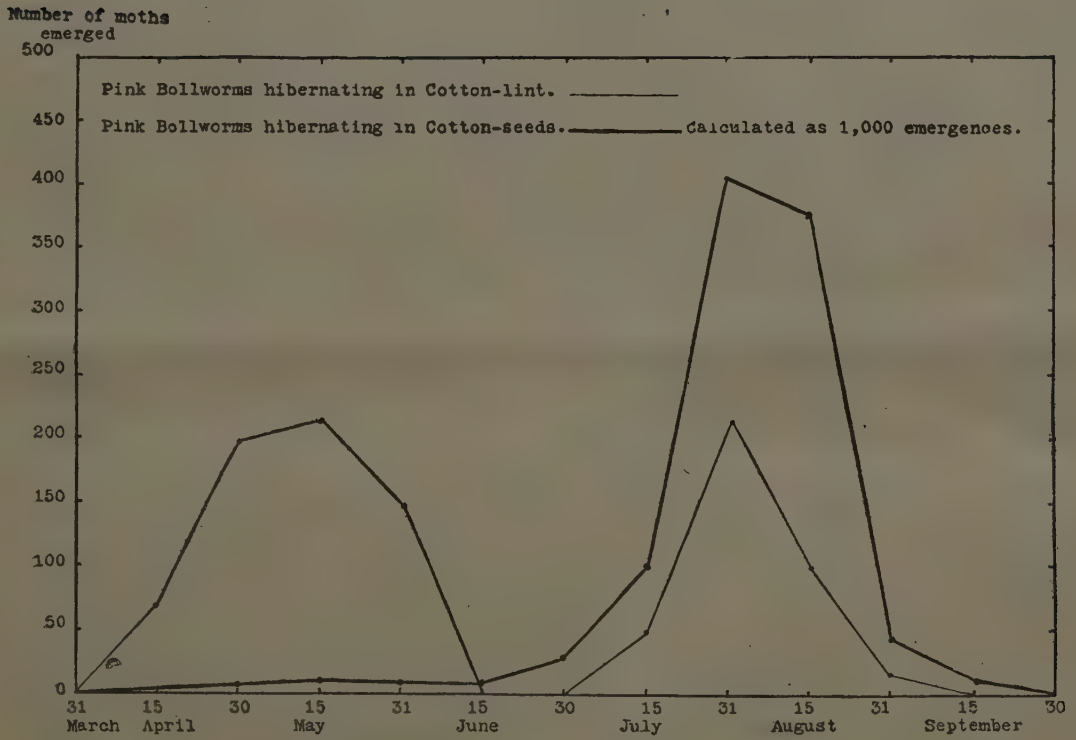
PLATE XXVIII.



Emergence of long-cycle moths from open bolls (seed-cotton) of different pickings.

PLATE XXIX

PLATE XXX.



Emergence of long-cycle moths from lint-worms and seed-worms.

The explanation given above seems most plausible but the matter requires elucidation.

The possible relationship between the emergence of long-cycle moths and the temperature prevailing in the rearing room is shown on Plate XXVIII. It is significant that the main emergence of long-cycle moths began about three to four weeks after the hottest days in the Punjab, but the main rush of emergences was during the hot period.

The emergences secured from *kapas* of different pickings do not show any striking variation, but there appears to be a tendency in caterpillars resting in *kapas* of the early (October) pickings to emerge as moths in the first (April and May) rush of emergences and those resting in the late (November and December) pickings to emerge during the second (July and August) rush of emergences (Plate XXIX).

In experiments carried out during 1924 the emergence of moths from (1) Worms in lint, *i.e.*, the caterpillars found resting either free in cotton lint or in fine silken cocoons spun in the lint, and (2) Worms in seeds, *i.e.*, the caterpillars found in resting-chambers formed by the seeds, were recorded separately. The latter were further divided into two lots :—(*a*) Worms in single or 2-seeded resting-chambers, (*b*) worms in 3 to 5-seeded resting-chambers. Table No. XI gives details of these observations. It was noticed that the emergence of moths from caterpillars resting in lint was early, and a large number of moths emerged during April and May and the remaining during July and August; while in the case of caterpillars in seeds, the emergence was meagre till the beginning of July and reached its maximum towards the end of July and the beginning of August (Plate XXX). Thus one finds that, while in caterpillars in seeds there was a single period of 'rush of emergences,' for those in the lint there were two such periods.[1]

As regards the proportion of resting caterpillars which reached the adult stage, it was 17 per cent. in the case of worms in the seeds, as against 5·4 per cent. of worms in the lint. The caterpillars resting in different types of seed-chambers showed practically no difference as regards the time of emergence, but the number of moths emerging from them varied directly with the number of seeds forming the chamber, *i.e.*, the emergence was 15·9 per cent. from worms in single and 2-seeded resting-chambers and 23·6 per cent. from those resting in 3 to 5-seeded ones.

Thus it will be seen that, of the caterpillars resting in picked cotton, it is the worms in seeds that form the main source of infection of the new crop. All precautionary measures should certainly be taken against seed-worms, but at the same time lint-worms should not be ignored. If the whole of the cotton crop is ginned before the middle of March, the chances are that caterpillars lint will all die. But the low grade *kapas* which is stored in ginning factories for cleaning the gins, the heap of *patti*[2] left under the riddle in ginning factories, open bolls

[1] In the experiments carried out during 1927, most of the lint-worms emerged as moths during April and May and very few during July and August.

[2] This is a coarse material seen in cotton ginning factories under the riddle (vernacular name *Jaffary*). It consists mostly of dust and withered leaves and small branches of cotton plants.

and loculi which have dropped in the fields or elsewhere, and lastly *kapas* stored by petty shopkeepers and villagers, will still remain the main sources of infection.

Emergence of Long-cycle moths from green bolls and the proportion of Short and Long-cycle caterpillars present in green bolls collected at various dates.

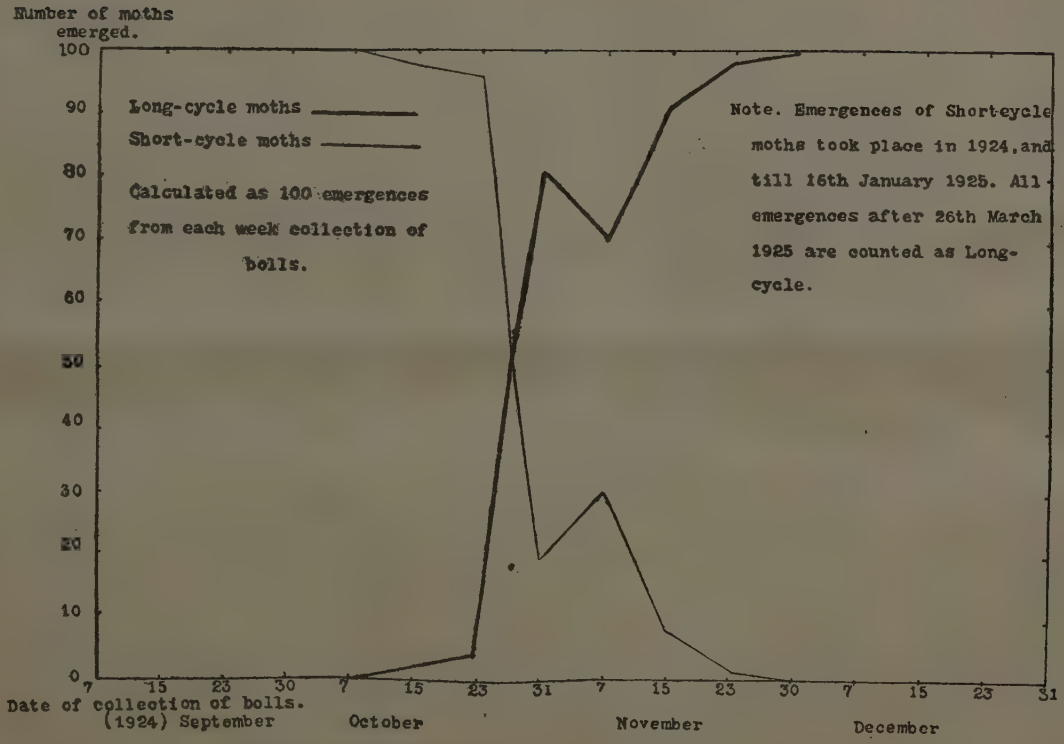
The Pink Bollworms resting in green bolls are probably of less importance than those in open bolls. These caterpillars, being left in the fields or carried along with the cotton sticks, are placed under more adverse conditions than those in open bolls, which find their way to the ginneries where a favourable atmosphere is provided for them in the stores. With a view to obtain information regarding the emergence of long-cycle moths and to ascertain the presence of long and short-cycle caterpillars of *P. gossypiella*, Saund., in green bolls during the cotton season, a weekly supply of bolls was procured from September to December 1924, collected from different localities in the South-eastern Punjab.

Each sample was placed in a cage having fine brass wire gauze all round, and a removable glass cover at the top. For lack of sufficient cages, rearing was also done in glass dishes. In all about one hundred cages and dishes were used and the experiment continued for full one year, from September 1924 to August 1925.

The emergence of moths from each cage or dish was recorded every day, but for convenience, the daily records have been added into fortnightly figures, which are given in Table No. XII. It will be seen that the emergence of moths continued from September 1924 to January 1925, and from March to August 1925. There were, however, no emergence for a period of 68 days, from 17th January to 25th March 1925.[1] All the moths that emerged before 17th January 1925 were regarded as short-cycle moths and those after 25th March 1925 as long-cycle moths.

In Table No. XII, column 18 gives the actual number of long-cycle moths that emerged, and in column 19 this number has been calculated per 1,000 so as to facilitate comparison. In Plate I,the data are represented by a curve, which shows that the emergence of long-cycle moths from green bolls was almost similar to that from open bolls except that there was no emergence after the third week of August, and comparatively more moths came out during April to June. Table No. XII also records the emergence of short-cycle moths from each week's (September to December, 1924) collection of green bolls. As the number of bolls under observation, for each week's collection, differed, therefore, in order to facilitate comparison the emergences from each week's material have been calculated

[1] In Egypt, as pointed out by Willcocks (p. 152), the period of absolute quiescence is of 81 days, 21st January to 12th April.



Presence of short and long-cycle moths in green bolls collected at various dates.

on the basis of one hundred moths, and the figures so obtained are represented in the form of curves on Plate XXXI. It will be seen that during the first five weeks, *viz.*, 1st September to 7th October, all the caterpillers present in green bolls belonged to the short-cycle generation, and those present during the last five weeks, *viz.*, 24th November to 31st December, belonged to the long-cycle brood. It was only the caterpillars in the intervening period of six weeks, *i.e.*, 8th October to 23rd November, that belonged both to short and long-cycle broods. It will also be seen that during the first two weeks, *i.e.*, 8th October to 23rd October, the number of the long-cycle larvæ was very small (4 per cent.), while during the latter four weeks, *i.e.*, 24th October to 23rd November, their number increased enormously and was as high as 75 per cent. or even more. Thus the first appreciable increase in the number of the long-cycle caterpillars in green bolls was after 24th October, though the first appearance of such larvæ was noticed on 8th October. The short-cycle larvæ were noticed as late as 20th November, and it was about 25th October that the number of short and long-cycle caterpillars was equal in green bolls.

In Table No. XIII, figures of Table No. XII have been rearranged so as to indicate in weeks the variation of the resting period of Pink-Bollworm in green bolls. It will be seen that Pink-Bollworm can remain in resting condition from 12 to as many as 40 weeks ; this period being less in the case of caterpillars entering the resting stage during December than in case of those that start resting in October or November.

In the end it will not be out of place to mention that in the present investigation the duration of resting stage of Pink-Bollworm was found to be less than a year, and the emergence of a large number of moths was recorded during July and August, the period when cotton crop was beginning to have buds, flowers and bolls, and thus provide suitable conditions for the newly hatched caterpillars.

Distinction between real and apparent damage.

The figures showing the extent of attack of Pink-Bollworm on green bolls, *kapas* and cotton-seeds, as worked out in the present case, give an idea of the relative abundance of the insect, but do not in any way represent the extent of actual damage done to the cotton crop.

When determining the extent of infestation in a crop, distinction must be made between the ' real damage ' and the ' apparent damage.' From an examination of picked cotton one can only obtain an idea of the damage done to those bolls which had reached maturity and produced pickable cotton, but cannot gain any information about the fate of those bolls that did not mature because of the damage done to them by Pink-Bollworm and other cotton pests. Thus the real damage to the crop must always be regarded as much higher than the apparent damage. Further, as samples of *kapas* were examined from 1st January to 31st March, *i.e.*, four to sixteen weeks after the cotton was picked, it is possible, in fact probable, that many of the larvæ had emerged out as moths and were not taken into

consideration and thus even the 'apparent damage' was below the actual loss. Lastly, there remains the possibility of the caterpillars leaving the open bolls to pupate elsewhere, and if this possibility is taken into account, the figures for 'real damage' would be higher still.

The observations made on green bolls give a better idea of the severity of Pink-Bollworm attack than those on seed-cotton, because green bolls, harbouring relatively a large number of caterpillars, give a true indication of the state of attack. But even the figures of attack obtained from the examination of green bolls are below the real figures of damage, for the bolls shed due to attack have not been taken into consideration.

Financial loss to the cotton crop.

The yearly financial loss caused by the attack of Bollworms to the cotton crop is undoubtedly considerable. In most localities of the South-eastern Punjab the major portion of the loss is certainly caused by Pink-Bollworm, but in the Colony areas Spotted-Bollworm appears to be the predominant species. The other Bollworms, such as *Heliothis obsoleta*, *Dichocrocis punctiferalis*, have always held the third place in importance as cotton pest. Calculating on the basis of correlation between the percentage of attacked seeds in pickable cotton (Table No. IV) and the percentage of loss in the seed-cotton, which has been determined by Egyptian workers[1], the annual loss to cotton crop amounts to over sixty *lakhs* of rupees. It may be pointed out that the percentage of damaged seeds was calculated from samples ginned in the factories, and it is certain that a large portion of the damaged seeds must have been crushed to pieces during the ginning operation and could not be taken into account. Moreover, a certain proportion of seeds was totally consumed and no trace was left of them. It, therefore, appears that the actual loss must have been considerably more than sixty *lakhs*, and may be safely put down as one *crore* of rupees. In addition to the failure of cotton to the extent of sixty *lakhs* due to Bollworms, there is always a considerable loss due to the low price at which damaged seeds and inferior quality of *kapas* are sold. If this amount is also taken into consideration then the loss will exceed rupees one *crore*.

Summary.

(1) The facts brought forward go to prove that Pink-Bollworm is a serious pest of cotton-seeds in the South-eastern Punjab, but its intensity of attack is successively reduced in the Eastern region, Central Punjab and the Northern Area, and is least in the Western Punjab including the Colony areas. It seems likely that the climatic conditions in the Western Punjab are so adverse to the increase

[1] Abrahm Bishera. A preliminary note on the estimation of loss by Bollworms. *Tech. and Sci. Bull. No. 39, Min. Agri., Egypt*, Cairo, *1924*, p. *20*.

of Pink-Bollworm that it has not been able to attain the status of a pest. On account of the rapid changes that are taking place in the climatic conditions in the irrigated tracts, these tracts at no distant date may, however, become a congenial place for the pest.

(2) The attack of Pink-Bollworm differs at different times during the growing period of cotton. In the South-eastern Punjab its attack in the beginning of August is 10 per cent. on bolls, 8·4 per cent. on loculi, and 4·4 per cent. on seeds, but towards the end of September it reaches 15·2 per cent. on bolls, 9·7 per cent. on loculi, and 5·1 per cent. on seeds. After the middle of October the progress of attack is very rapid and it reaches its maximum (63 per cent. on bolls, 42 per cent. on loculi, and 18 per cent. on seeds) by the end of December. The above mentioned rate of increase of this insect is calculated irrespective of the number of bolls actually present on the plants. During November and December the population of green bolls on the plants decreases considerably and consequently the proportion of attacked bolls in the fields increases. It is during October that the damage caused by Pink-Bollworm is the maximum.

(3) As compared to Pink-Bollworm, the Spotted-Bollworm is a minor pest in the South-eastern Punjab ; its attack varies between 1·1 per cent. and 3·9 per cent., the main period of its activity being before the middle of September, *i.e.*, a month earlier than that of Pink-Bollworm. The number of bolls affected by a combined attack of Pink and Spotted-Bollworms is very slight and does not exceed 2 per cent. The attack of both the Bollworms on green bolls (bolls actually containing one or more caterpillar or showing mere signs of damage) reaches 30 per cent. even in the beginning of the season, *i.e.*, towards the end of August. After a period of six weeks, *i.e.*, towards the beginning of October, the attack rises by another 20 per cent. until in the beginning of December 70 per cent. of the bolls are attacked.

(4) The number of Pink-Bollworms infesting an attacked boll is one in August, one to five in September, one to six in October, one to ten in November and one to nine in December. The attacked loculi contain, as a rule, one Pink-Bollworm in August, one to three in September and October, one to five in November and one to four in December.

(5) The attack of Pink-Bollworm varies in *kapas* of different pickings; early and middle pickings are generally affected to a moderate degree, whilst late pickings are seriously damaged.

(6) A large number of Pink-Bollworms pass the resting stage in picked cotton. They are mostly found in seeds, but a few are found in lint, either free or in fine silken cocoons. Of caterpillars resting in lint, about 5 per cent. reach the imago stage under laboratory conditions. The moths emerging from these caterpillars show two periods of ' rush of emergences' ; the first period is during April and May, and the second during July and August. During April and May the cottons are still in the germinating stage in the Punjab, and most probably moths

emerging at this time do not contribute towards the damage done to the crop. The second 'rush of emergences' is certainly dangerous because during this period (July and August) the crop is bearing bolls, buds and flowers, and Pink-Bollworms can find ample food for their development.

(7) The caterpillars resting in seeds are mostly found in 2-seeded chambers, a lesser number in 3-seeded chambers, lesser still in single-seeded chambers and least in 4 and 5-seeded chambers. Of caterpillars resting in seeds, about 17 per cent. reaches the imago stage under laboratory conditions. The emergence of moths from these caterpillars continues from April to November, but the main rush is during July and the first half of August—the period when the cotton crop is producing bolls in quick succession, and thus provides most suitable condition for the newly hatched caterpillars.

(8) The emergence of moths, short and long-cycle, of *Platyedra gossypiella*, Saund., continues throughout the year except for a period of about ten weeks, from 17th January to 25th March. The emergence of long-cycle moths continues from April to November, the maximum being in July and the first half of August.

(9) All the Pink-Bollworms present in green bolls before 7th October belong to the short-cycle brood, and after 21st November to the long-cycle generation, while caterpillars present from 8th October to 20th November belong both to the short and long-cycle broods. It is sometimes about the 25th October that the number of short and long-cycle caterpillars is equal in green bolls. In the present investigation the resting period of Pink-Bollworm is found to vary from 12 to 40 weeks.

TABLE I.

Relative accuracy of samples of 50 and 100 green bolls each.

Locality	Date of taking sample	Serial No. of sample	Number of bolls examined	Number of bolls attacked by Pink-Bollworm	Percentage of attacked bolls	Deviation from normal percentage attack
1	2	3	4	5	6	7
Ballabgarh (District Rohtak)	6th December, 1924.	1	50	37	74	+6
		2	50	29	58	—10
		3	50	33	66	—2
		4	50	34	68	0
		5	50	42	84	+16
		6	50	37	74	+6
		7	50	35	70	+2
		8	50	34	68	0
		9	50	35	70	+2
		10	50	30	60	—8
		11	50	35	70	+2
		12	50	30	60	—8
	Average .	..	..	..	68	..
Ambala . . .	18th December, 1924.	1	50	25	50	+6
		2	50	19	38	—6
		3	50	16	32	—12
		4	50	19	38	—6
		5	50	16	32	—12
		6	50	25	50	+6
		7	50	29	58	+14
		8	50	27	54	+10
	Average .	..	..	..	44	..
Ballabgarh . . .	....	1 & 2	100	66	66	—2
		3 & 4	100	67	67	—1
		5 & 6	100	79	79	+11
		7 & 8	100	69	69	+1
		9 & 10	100	65	65	—3
		11 & 12	100	65	65	—3
Ambala	....	1 & 2	100	44	44	0
		3 & 4	100	35	35	—9
		5 & 6	100	41	41	—3
		7 & 8	100	56	56	+12

TABLE II.

Attack of Pink-Bollworm on green bolls during kharif, 1924.

Region	Date of taking samples	Variety of cotton	Number of samples examined	Number of Green Bolls		
				Examined	Attacked by Pink-Bollworm	Percentage attack
1	2	3	4	5	6	7
	1924.					
I. South-eastern Punjab	1st to 15th Aug.	*Desi*	4	319	6	1·9
	16th to 31st Aug.		14	1,004	45	4·5
	1st to 14th Sept.		22	1,896	188	10·0
	16th to 30th Sept.		29	2,951	435	14·7
	1st to 15th Oct.		36	3,472	654	18·8
	16th to 31st Oct.		37	3,676	1,360	36·9
	1st to 15th Nov.		37	3,241	1,384	42·7
	16th to 30th Nov.		29	2,731	1,285	47·1
	1st to 15th Dec.		37	2,951	2,000	67·7
	16th to 31st Dec.		19	1,687	1,115	66·1
	16th to 31st Aug.	American	1	92	1	1·1
	1st to 15th Sept.		5	564	14	2·5
	16th to 30th Sept.		12	1,159	68	5·9
	1st to 15th Oct.		13	1,331	125	9·4
	16th to 31st Oct.		13	1,239	296	23·9
	1st to 15th Nov.		9	737	237	32·1
	16th to 30th Nov.		8	702	181	25·8
	1st to 15th Dec.		6	509	142	27·9
	16th to 31st Dec.		5	453	271	59·8
II. Eastern Punjab	16th to 31st Dec.	*Desi*	8	400	176	44·0
	1st to 15th Nov.	American	1	82	46	56·1
III. Central Punjab	15th to 30th Sept.	*Desi*	2	153	8	5·2
	1st to 15th Oct.		2	210	15	7·1
	16th to 31st Oct.		6	457	11	2·4
	1st to 15th Nov.		1	185	6	3·2
	16th to 30th Nov.		1	93	39	41·9
	16th to 31st Oct.	American	3	284	4	1·4
IV. Northern Area	...	...	...	...	...	...
V. Western Punjab including the Colony areas.	1st to 15th Aug.	*Desi*	1	100	0	0
	16th to 31st Aug.		2	161	3	1·2
	1st to 15th Sept.		1	100	0	0
	16th to 30th Sept		1	100	1	1·0
	1st to 15th Oct.		1	100	1	1·0
	16th to 31st Oct.		1	100	1	1·0
	1st to 15th Nov.		4	330	5	1·5
	16th to 30th Nov.		6	650	2	0·3
	1st to 15th Dec		9	872	40	4·6
	16th to 31st Dec.		1	125	5	4·0
	1st to 15th Oct.	American	1	100	0	0
	16th to 31st Oct.		1	100	0	0
	1st to 15th Nov.		3	290	0	0
	16th to 30th Nov		1	100	1	1·0
	1st to 15th Dec.		14	1,047	34	3·2

TABLE III.

Infestation of Pink-Bollworm in kapas (seed-cotton) during kharif, 1923 and 1924.

District	*Tahsil*	No. of samples examined	Weight in *tolas* of *kapas* examined	No. of Pink-Bollworms found	No. of Pink-Bollworms calculated per 100 *tolas* of *kapas*
1. Gurgaon	Gurgaon **	3	120	430	358
	Palwal *	1	20	43	215
	Nuh *	1	44	145	330
	Firozpur Jhirka *	2	47	113	240
	TOTAL	7	231	731	316
2. Rohtak	Rohtak *	2	72	291	401
	Guhana **	6	120	565	471
	TOTAL	8	192	856	445
3. Karnal	Karnal	16	476	1,090	229
	Kaithal	4	119	266	223
	Panipat **	7	142	829	584
	TOTAL	27	737	2,185	295
4. Hissar	Hissar	3	157	430	274
	Hansi	19	514	938	182
	Bhiwani *	2	82	169	206
	Fatehabad	1	44	67	152
	TOTAL	25	797	1,604	201
5. Ferozepore	Ferozepore*	11	549	1,958	357
	Moga	19	728	2,911	392
	Zira **	1	20	29	145
	Mukatsar	7	157	123	78
	Fazilka	11	397	229	58
	TOTAL	49	2,051	5,250	256
6. Ludhiana	Samrala	14	378	1,191	315
	Jagraon **	3	60	181	302
	TOTAL	17	438	1,372	313

TABLE III—*contd.*

Infestation of Pink-Bollworm in kapas (seed-cotton) during kharif, 1923 and 1924—contd.

District	*Tahsil*	No. of samples examined	Weight in *tolas* of *kapas* examined	No. of Pink-Bollworms found	No. of Pink-Bollworms calculated per 100 *tolas* of *kapas*
7. Jullundhar	Jullundhar	20	478	1,619	339
	Nakodar	10	224	780	348
	Phillaur	7	147	745	507
	TOTAL	37	849	3,144	370
I. South-eastern Punjab	TOTAL	170	5,065	15,142	299
9. Ambala	Ambala	9	301	301	100
	Jagadhri **	6	180	225	125
	Naraingarh **	6	181	338	186
	Kharar **	9	241	239	99
	Ropar **	9	242	158	65
	TOTAL	39	1,145	1,261	110
10. Hoshiarpur	Hoshiarpur	5	145	274	189
	Una **	6	167	33	19
	Dasuha	25	474	1,631	344
	TOTAL	36	786	1,938	247
11. Kangra	Kangra	7	184	234	127
	Palampur	4	108	221	205
	Dehra	4	99	289	290
	Hamirpur	7	182	356	196
	TOTAL	22	573	1,100	192
12. Gurdaspur	Gurdaspur	3	82	126	152
	Pathankot	4	104	332	319
	Shakargarh	10	280	464	166
	Batala	4	100	56	56
	TOTAL	21	566	978	173

TABLE III—*contd.*

Infestation of Pink-Bollworm in kapas (seed-cotton) during kharif, 1923 and 1924—contd.

District	*Tahsil*	No. of samples examined	Weight in *tolas* of *kapas* examined	No. of Pink-Bollworms found	No. of Pink-Bollworms calculated per 100 *tolas* of *kapas*
13. Amritsar	Amritsar	17	521	527	101
	Taran Taran	37	1,075	1,354	126
	Ajnala **	12	240	315	131
	TOTAL	66	1,836	2,196	120
14. Sialkot	Sialkot	27	675	2,440	362
	Narowal **	3	79	160	203
	Daska **	18	360	433	120
	Pasrur	5	151	274	181
	TOTAL	53	1,265	3,307	261
II. Eastern Punjab	TOTAL	237	6,171	10,780	175
15. Lahore	Lahore	13	276	163	95
	Chunian	16	476	250	53
	Kasur **	7	232	175	76
	TOTAL	36	984	588	60
16. Gujranwala	Gujranwala	8	205	123	60
	Wazirabad	4	143	85	60
	Hafizabad	19	462	141	31
	TOTAL	31	810	349	43
17. Gujrat	Gujrat	6	244	277	113
	Kharian **	5	210	267	127
	Phalian **	6	120	112	93
	TOTAL	17	574	656	114
III. Central Punjab	TOTAL	84	2,368	1,593	67
18. Jhelum	Jhelum	7	164	171	104
	Chakwal	10	215	16	8
	Pind Dadan Khan **	3	60	4	7
	TOTAL	20	439	191	43

TABLE III—*contd.*

Infestation of Pink-Bollworm in kapas (seed-cotton) during kharif, 1923 and 1924—contd.

District	*Tahsil*	No. of samples examined	Weight in *tolas* of *kapas* examined	No. of Pink-Bollworms found	No. of Pink-Bollworms calculated per 100 *tolas* of *kapas*
19. Rawalpindi .	Rawalpindi . .	9	297	29	10
	Kahuta . .	3	132	25	19
	Gujarkhan . .	9	305	235	77
	TOTAL .	21	734	289	39
20. Campbellpore	Campbellpore ** .	15	326	58	18
	Talagang . .	5	125	16	13
	Fatehjang . .	8	180	28	16
	Pindigheb * . .	1	45	2	5
	TOTAL .	29	676	104	15
IV. Northern Region . . .	TOTAL .	70	1,849	584	32
21. Mianwali . . .	Mianwali ** . .	9	224	3	1
	Isakhel ** . .	12	260	0	0
	Bhakhar ** . .	6	120	0	0
	TOTAL .	27	604	3	1
22. Muzaffargarh	Muzaffargarh .	10	225	50	22
	Leiah . . .	15	322	0	0
	Alipur ** . .	5	210	28	13
	TOTAL .	30	757	78	10
23. Dera Ghazi Khan .	D. G. Khan . .	15	336	15	4
	Sanghar ** . .	6	140	8	6
	Jampur ** . .	3	120	12	10
	Rajanpur ** . .	3	125	40	32
	TOTAL .	27	721	75	10

TABLE III—*concld.*

Infestation of Pink-Bollworm in kapas (seed-cotton) during kharif, 1923 and 1924—contd.

District	*Tahsil*	No. of samples examined	Weight in *tolas* of *kapas* examined	No. of Pink-Bollworms found	No. of Pink-Bollworms calculated per 100 *tolas* of *kapas*
24. Multan	Multan **	33	700	3	1
	Shujabad **	3	104	0	0
	Lodhran	33	791	56	7
	Kabirwala **	30	616	0	0
	Mailsi **	12	278	26	9
	TOTAL	111	2,489	85	3
25. Montgomery	Montgomery	37	1,364	53	4
	Dipalpur **	24	551	227	41
	Okara **	35	890	260	29
	TOTAL	96	2,805	540	19
26. Sheikhupura	Sheikhupura	46	1,069	154	14
	Nankana Sahib **	10	292	6	2
	Shahdara **	7	272	151	55
	TOTAL	63	1,633	311	19
27. Lyallpur	Lyallpur	16	615	30	5
28. Jhang	Jhang	11	311	2	1
	Chiniot **	20	802	62	8
	Shorkot **	6	285	3	1
	TOTAL	37	1,398	67	5
29. Shahpur	Shahpur	7	136	3	2
	Sargodha	7	268	14	5
	Khushab **	12	337	35	10
	Bhalwal	26	578	142	25
	TOTAL	52	1,319	194	15
V. Western Punjab including the Colony area.	TOTAL	459	12,341	1,383	11

NOTE.—Samples of *kharif* 1923, only were examined from *tahsils* marked (*), of *kharif* 1924, from *tahsils* marked (**), while from the rest the samples were for both the seasons.

TABLE IV.

Number of Pink-Bollworms found and cotton seeds damaged during kharif, 1923 and 1924.

District	Number of samples examined	Total Number of seeds examined	Number of seeds damaged by Bollworms	Percentage of damaged seeds	Number of Pink-Bollworms found	Number of Pink-Bollworms calculated per 10,000 seeds
1. Gurgaon	3	16,913	3,690	21·8	255	150
2. Karnal	1	9,145	1,635	17·8	61	66
3. Rohtak	16	86,380	19,432	22·5	550	64
4. Hissar	9	48,389	5,936	12·2	154	32
5. Ferozepore	5	36,210	3,111	8·5	94	26
6. Jullundhar	9	44,887	2,603	5·8	83	19
7. Ludhiana	7	48,316	3,569	7·3	112	23
I. South-eastern Punjab	50	2,90,240	39,976	13·8	1,309	45
8. Ambala	2	10,413	615	5·9	71	68
9. Hoshiarpur	2	9,925	658	6·6	63	63
10. Gurdaspur	3	20,702	900	4·3	30	14
11. Sialkot	2	10,451	545	5·2	11	11
11. Kangra	6	36,392	2,120	5·8	116	32
13. Amritsar	2	9,219	454	4·9	25	27
II. Eastern Punjab	17	97,102	5,292	5·4	316	32
14. Lahore	7	44,523	1,801	4·0	17	4
15. Gujranwala	6	33,571	1,609	4·7	29	9
16. Gujrat	2	20,600	1,060	5·1	60	29
III. Central Punjab	15	98,694	4,470	4·5	106	11
17. Jhelum	3	16,074	580	3·6	25	15
18. Rawalpindi	3	29,092	781	2·6	21	7
19. Campbellpore	3	23,173	414	1·7	6	3
IV. Northern Area	9	68,339	1,775	2·5	52	7
20. Mianwali	3	14,162	326	2·3	4	3
21. Muzaffargarh	3	16,294	644	3·9	0	0
22. Dera Ghazi Khan	3	26,442	397	1·5	0	0
23. Multan	2	6,455	60	0·9	0	0
24. Montgomery	1	5,460	55	1·0	1	2
25. Lyallpur	2	13,627	152	1·1	0	0
26. Shahpur	2	7,368	110	1·4	1	1
27. Jhang	*Nil*	..	..	..	..	..
28. Sheikhupura	3	33,048	1,337	4·0	49	14
V. Western Punjab including the Colony areas.	19	1,22,856	3,081	2·5	55	4

TABLE V.

Seasonal variation in the intensity of Bollworm attack in green bolls of Desi *cottons, in the South-eastern Punjab, during August to December, 1924 and 1925.*

District and Tahsil	Date of taking sample (year 1924 and 1925)	Number of bolls examined	PINK-BOLLWORM					Per cent. bolls attacked by Spotted Bollworms	Per cent. bolls showing *sims* of Bollworm attack	Total of columns 4, 9 & 10	Number of Pink-Bollworms found per 100 bolls examined
			Per cent. bolls attacked	Per cent. loculi attacked	Per cent. seeds attacked	Absolute per cent. of attacked loculi	Absolute per cent. of attacked seeds				
1	2	3	4	5	6	7	8	9	10	11	12
I. DISTRICT FEROZEPORE.											
1. Tahsil Ferozepore	1st to 15th Aug.	181	14·9	68·5	40·0	10·2	5·9	1·1	13·8	29·8	18·2
	16th to 31st Aug.	123	30·1	71·2	46·1	22·7	15·8	6·5	21·1	57·7	38·2
	1st to 15th Sept.	246	14·6	72·1	45·1	11·3	6·5	6·9	21·1	42·6	18·7
	16th to 30th Sept.	300	14·0	43·8	23·7	6·0	3·3	1·6	12·3	28·0	16·3
	1st to 15th Oct.	470	15·9	73·2	47·2	11·3	7·2	1·2	15·5	32·7	25·7
	16th to 31st Oct.	389	29·0	61·2	27·1	17·2	7·9	0·8	8·4	38·3	45·7
	1st to 15th Nov.	220	36·3	49·4	16·7	16·5	6·3	1·4	7·3	45·0	50·0
	16th to 30th Nov.	437	39·1	60·0	20·7	24·5	8·8	0·7	8·5	48·3	76·2
	1st to 15th Dec.	197	54·8	69·7	34·5	37·4	17·2	1·1	9·1	65·0	76·1
	16th to 31st Dec.	100	76·0	71·0	41·5	54·2	30·4	0	5·0	81·0	96·0
2. Tahsil Moga	1st to 15th Aug.	71	30·0	59·5	35·8	19·2	11·1	1·4	11·2	43·6	36·6
	16th to 31st Aug.	46	26·1	54·1	30·1	13·1	7·4	0	21·7	47·8	28·7
	1st to 15th Sept.	221	35·8	76·4	48·0	26·6	17·2	1·8	25·8	63·3	46·6
	16th to 30th Sept.	200	11·0	55·2	28·8	5·6	2·8	0	18·5	29·5	11·5
	1st to 15th Oct.	147	19·1	60·2	35·4	12·0	7·3	0·7	17·0	37·4	28·6
	16th to 31st Oct.	193	44·0	64·0	26·8	27·4	11·3	0·5	9·3	53·9	74·1
	1st to 15th Nov.	134	26·8	55·4	28·6	15·3	7·8	0	17·9	44·7	38·1

TABLE V—*contd.*

Seasonal variation in the intensity of Bollworm attack in green bolls of Desi *cottons, in the South-eastern Punjab, during August to December, 1924 and 1925*—contd.

District and Tahsil	Date of taking sample (year 1924 and 1925)	Number of bolls examined	PINK-BOLLWORM					Per cent. bolls attacked by Spotted Bollworms	Per cent. bolls showing *sign* of Bollworm attack	Total of columns 4, 9 & 10	Number of Pink-Bollworms found per 100 bolls examined
			Per cent. bolls attacked	Per cent. loculi attacked	Per cent. seeds attacked	Absolute per cent. of attacked loculi	Absolute per cent. of attacked seeds				
1	2	3	4	5	6	7	8	9	10	11	12
I. DISTRICT FEROZEPORE —*contd.*											
2. Tahsil Moga—*contd.*	16th to 30th Nov.	100	48·0	82·8	37·5	41·1	18·7	0	5·0	53·0	72·0
	1st to 15th Dec. .	100	43·0	55·7	23·9	24·0	10·3	7·0	3·0	53·0	64·0
	16th to 31st Dec.	96	26·0	48·2	23·2	12·3	5·8	5·2	3·1	34·4	33·3
3. Tahsil Zira . .	1st to 15th Aug. .	187	14·9	54·4	20·5	8·2	3·0	1·1	10·1	26·2	18·7
	16th to 31st Aug.	299	13·0	73·0	49·5	9·6	6·6	7·7	3·3	24·0	35·8
	1st to 15th Sept.	209	2·9	55·0	23·6	1·6	0·6	6·7	13·0	22·5	2·9
	16th to 30th Sept.	200	17·5	44·7	23·7	8·1	4·2	1·0	16·0	34·5	19·5
	1st to 15th Oct. .	200	16·5	67·0	38·6	10·5	4·9	0·5	17·5	34·5	19·0
	16th to 31st Oct.	220	35·0	57·0	23·2	20·1	8·4	0·5	7·7	43·2	60·2
	1st to 15th Nov. .	168	46·0	54·5	30·2	24·9	14·0	1·8	17·2	65·0	78·5
	16th to 30th Nov.	114	52·6	61·1	37·3	32·2	19·3	0	20·2	72·8	92·1
4. Tahsil Muktsar .	1st to 15th Aug. .	56	3·6	28·7	8·7	1·1	0·3	0	8·9	12·5	3·6
	16th to 31st Aug.	.. .	..	..	..	..	..	..	..	..	..
	1st to 15th Sept.	204	7·3	46·0	25·7	3·4	2·0	8·3	20·5	36·7	8·8
	16th to 30th Sept.	298	8·3	53·8	30·3	5·2	3·1	14·7	20·8	43·9	10·1
	1st to 15th Oct. .	453	5·5	57·3	20·7	3·1	1·2	3·5	11·5	20·5	7·6
	16th to 31st Oct.	158	22·8	64·3	17·5	13·6	1·6	0	17·1	39·8	30·3

	1st to 15th Nov. .	376	29·7	62·2	33·6	19·1	10·4	1·0	17·8	48·6	51·6
	16th to 30th Nov.	158	34·1	48·4	18·5	16·4	6·0	0	13·2	47·4	55·0
	1st to 15th Dec. .	143	49·6	55·1	23·7	27·7	12·1	1·4	16·7	67·1	90·2
	16th to 31st Dec.	95	53·6	59·5	20·5	32·3	11·0	3·1	11·5	78·4	86·3
5. Tahsil Fazilka . .	1st to 15th Aug. .	..	..	..	..	..	..	..	..	..	..
	16th to 31st Aug.	150	2·0	33·3	22·0	0·6	0·4	4·0	2·6	8·6	2·0
	1st to 15th Sept.	319	2·9	42·8	22·5	1·1	0·6	7·5	4·4	14·7	2·9
	16th to 30th Sept.	269	5·2	53·4	29·8	2·6	1·4	2·6	4·4	12·2	5·9
	1st to 15th Oct. .	503	3·8	53·9	26·6	3·9	1·0	2·0	7·5	13·3	3·8
	16th to 31st Oct.	489	13·0	66·5	33·2	8·6	4·3	2·3	11·5	26·6	17·6
	1st to 15th Nov. .	479	25·0	53·2	21·4	14·1	5·4	2·0	10·4	37·5	34·2
	16th to 30th Nov.	479	20·9	54·7	19·1	11·9	4·3	2·1	7·0	29·8	30·7
	1st to 15th Dec. .	292	39·0	61·0	23·2	23·3	9·2	4·7	7·8	51·7	73·6
	16th to 31st Dec.	383	46·0	64·6	31·7	29·4	13·8	4·4	3·9	54·3	65·0
Total for District . .	1st to 15th Aug. .	495	16·0	60·0	31·3	9·9	5·1	1·0	11·5	28·5	19·4
	16th to 31st Aug.	618	14·7	69·0	45·0	10·4	7·2	6·0	8·1	28·8	27·5
	1st to 15th Sept.	1,199	12·1	69·1	42·7	8·4	5·3	6·3	16·0	34·4	15·2
	16th to 30th Sept.	1,267	10·9	48·6	26·3	5·4	3·0	4·6	14·2	28·7	13·5
	1st to 15th Oct. .	1,773	10·2	65·6	37·5	6·6	3·8	1·9	12·6	29·7	14·2
	16th to 31st Oct.	1,449	25·8	62·1	21·2	16·0	6·6	1·1	10·4	37·3	40·8
	1st to 15th Nov. .	1,377	30·8	55·3	25·9	17·4	8·2	1·5	13·5	45·8	47·3
	6th to 30th Nov.	1,288	33·5	60·2	24·2	21·0	8·6	1·0	9·2	43·9	57·8
	1st to 15th Dec. .	732	46·0	61·8	26·9	28·1	12·1	3·4	9·3	58·6	76·2
	16th to 31st Dec.	674	48·7	64·1	31·3	31·0	14·4	3·7	5·0	57·4	68·1
II. District Hissar.											
1. Tahsil Hissar . .	1st to 15th Aug. .	48	22·9	57·6	27·6	14·3	7·2	0	41·7	64·6	31·3
	16th to 31st Aug.	95	20·0	44·1	25·2	8·9	5·1	1·1	27·4	48·4	29·5
	1st to 15th Sept.	367	19·8	73·9	46·7	19·0	12·2	0·3	15·8	36·0	29·4
	16th to 30th Sept.	370	15·7	68·3	34·6	10·7	5·6	1·6	15·0	32·2	21·1

TABLE V—*contd.*

Seasonal variation in the intensity of Bollworm attack in green bolls of Desi *cottons, in the South-eastern Punjab, during August to December, 1924 and 1925*—contd.

District and Tahsil	Date of taking sample (year 1924 and 1925)	Number of bolls examined	PINK-BOLLWORM					Per cent. bolls attacked by Spotted Bollworms	Per cent. bolls showing *signs* of Bollworm attack	Total of columns 4, 9 & 10	Number of Pink-Bollworms found per 100 bolls examined
			Per cent. bolls attacked	Per cent. loculi attacked	Per cent. seeds attacked	Absolute per cent. o attacked loculi	Absolute per cent. of attacked seeds				
1	2	3	4	5	6	7	8	9	10	11	12
II. DISTRICT HISSAR—*contd.*											
Tahsil Hissar—*contd.*	1st to 15th Oct. .	529	16·8	87·7	43·7	18·0	7·6	0·2	14·4	31·4	30·4
	16th to 31st Oct.	306	48·4	75·6	36·2	39·1	15·6	0·3	7·8	56·5	74·5
	1st to 15th Nov. .	419	35·1	80·5	28·6	21·1	10·2	1·4	10·3	46·8	60·9
	16th to 30th Nov.	278	48·2	67·7	25·3	31·8	13·1	2·5	11·9	62·6	74·5
	1st to 15th Dec. .	177	62·7	69·8	37·1	44·6	25·7	0	15·8	78·5	131·6
	16th to 31st Dec.	183	71·8	70·2	26·8	50·4	18·5	3·3	8·7	83·6	135·0
2. Tahsil Sirsa . .	1st to 15th Aug. .	121	8·2	56·6	33·5	4·3	2·1	4·0	0	13·1	10·7
	16th to 31st Aug.	196	7·6	62·5	38·1	4·7	2·7	3·5	29·5	40·8	13·2
	1st to 15th Sept.	..	..	..	..	..	..	..	..	..	..
	16th to 30th Sept.	189	6·3	45·0	23·0	3·0	1·4	0·5	3·1	10·0	6·3
	1st to 15th Oct. .	192	37·5	65·9	26·8	24·3	9·8	0	6·7	44·2	48·4
	16th to 31st Oct.	278	35·9	71·2	39·3	25·7	13·9	0·3	22·6	58·9	65·4
	1st to 15th Nov. .	348	29·6	56·4	34·5	16·5	8·8	0·2	18·3	48·2	43·1
	16th to 30th Nov.	186	39·2	78·9	30·2	32·4	12·6	1·0	8·6	48·9	60·7
	1st to 15th Dec. .	100	69·0	75·2	28·8	51·8	18·7	0	12·0	81·0	145·0
3. Tahsil Fatehabad .	1st to 15th Sept.	56	8·9	64·7	37·8	5·6	3·3	1·8	28·6	39·3	8·9
	16th to 30th Sept.	201	20·4	52·3	14·9	10·4	2·9	0·1	26·3	47·8	24·9

	1st to 15th Oct. .	181	27·1	66·3	33·8	18·3	9·7	2·2	21·0	50·3	34·8
	16th to 31st Oct.	116	34·5	82·9	48·9	26·7	15·5	10·3	16·4	61·2	39·7
	1st to 15th Nov. .	167	32·9	57·5	20·8	19·1	7·2	1·2	15·0	49·1	58·1
	16th to 30th Nov.	173	34·1	74·0	34·4	26·0	12·1	0·6	13·3	48·0	47·4
4. Tahsil Bhawani . .	1st to 15th Sept.	164	18·9	61·0	34·8	11·8	6·0	0·6	21·3	40·8	26·8
	16th to 30th Sept.	262	15·6	62·1	37·6	8·3	5·4	1·1	17·1	34·0	16·8
	1st to 15th Oct. .	209	45·5	76·5	37·2	34·3	18·0	0	17·2	62·7	65·1
	16th to 31st Oct.	162	34·6	79·0	37·1	29·6	12·8	3·1	15·4	53·1	64·8
	1st to 15th Nov. .	268	44·8	67·7	28·9	30·2	12·8	0·7	14·6	60·1	71·3
	16th to 30th Nov.	172	46·5	72·7	36·0	33·4	32·0	1·1	5·8	53·5	74·4
	1st to 15th Dec. .	131	55·0	70·9	53·6	36·0	31·8	3·1	3·1	61·1	79·4
	16th to 31st Dec.	148	47·3	66·8	33·1	15·3	31·2	0·1	10·1	58·1	61·5
5. Tahsil Hansi . .	1st to 15th Aug. .	54	1·9	66·7	33·3	1·1	0·6	3·7	..	5·6	1·9
	16th to 31st Aug.	419	5·0	47·8	19·6	2·4	1·1	1·9	14·3	21·2	5·5
	1st to 15th Sept.	161	5·5	48·2	17·7	2·6	1·0	0·6	6·2	12·4	5·5
	16th to 30th Sept.	253	7·1	58·6	22·0	4·1	1·2	1·9	11·0	20·1	7·5
	1st to 15th Oct. .	785	17·8	54·2	26·4	9·3	4·5	0·8	9·9	28·5	21·7
	16th to 31st Oct.	583	38·0	68·3	20·5	27·5	8·4	0·7	14·4	53·1	46·2
	1st to 15th Nov. .	584	30·0	56·1	25·0	16·9	7·2	1·0	8·9	39·9	44·5
	16th to 30th Nov.	92	66·3	78·8	40·1	51·9	26·2	0	26·1	92·4	129·3
	1st to 15th Dec. .	605	53·7	66·5	33·1	35·8	18·2	1·5	10·4	65·6	101·8
	16th to 31st Dec.	250	79·2	72·2	34·5	56·8	27·2	0·8	2·0	82·0	152·4
Total for District . .	1st to 15th Aug. .	[illegible]8	9·9	57·6	30·3	5·5	2·8	3·6	9·0	22·4	13·0
	16th to 31st Aug.	710	7·7	50·3	26·3	4·4	2·1	2·3	20·3	30·3	10·8
	1st to 15th Sept.	748	15·8	68·2	31·0	12·1	7·3	0·5	15·9	32·2	22·2
	16th to 30th Sept.	1,275	13·3	60·1	28·6	7·7	3·6	1·3	14·7	29·3	15·9
	1st to 15th Oct. .	1,896	23·5	68·5	32·8	16·2	7·8	0·6	12·7	36·8	32·9
	16th to 31st Oct.	1,445	39·2	72·2	30·3	29·6	11·7	1·6	14·9	55·6	57·4

TABLE V—*contd.*

Seasonal variation in the intensity of Bollworm attack in green bolls of Desi *cottons, in the South-eastern Punjab, during August to December, 1924 and 1925*—contd.

District and Tahsil	Date of taking sample (year 1924 and 1925)	Number of bolls examined	Pink-Bollworm					Per cent. bolls attacked by Spotted Bollworms	Per cent. bolls showing *sims* of Bollworm attack.	Total of columns 4, 9 & 10	Number of Pink-Bollworms found per 100 bolls examined
			Per cent. bolls attacked	Per cent. loculi attacked	Per cent. seeds attacked	Absolute per cent. of attacked loculi	Absolute per cent. of attacked seeds				
1	2	3	4	5	6	7	8	9	10	11	12
II. District Hissar—*contd.*											
Total for District—*contd.*	1st to 15th Nov. .	1,686	35·6	63·4	27·9	20·0	9·0	1·0	13·2	49·8	56·5
	16th to 30th Nov.	501	45·2	73·4	33·4	33·1	17·3	1·3	11·8	58·3	72·0
	1st to 15th Dec. .	1,013	57·0	68·8	36·9	38·9	21·6	1·3	10·6	68·8	108·4
	16th to 31st Dec.	581	68·8	70·6	31·9	48·3	21·9	1·5	6·2	76·4	123·8
III. District Rohtak.											
1. Tahsil Rohtak . .	1st to 15th Sept.	399	18·0	68·7	43·9	12·4	8·7	0·5	21·5	40·1	29·8
	16th to 30th Sept.	479	12·3	70·0	37·4	8·1	4·6	1·6	21·7	35·6	13·9
	1st to 15th Oct. .	576	24·3	69·8	30·7	17·1	7·8	1·9	24·1	50·3	32·6
	16th to 31st Oct.	588	30·4	74·2	33·0	22·6	10·2	0·6	25·1	56·2	42·1
	1st to 15th Nov. .	230	50·4	75·0	35·1	37·0	17·8	2·6	22·6	75·6	83·9
	16th to 30th Nov.	350	49·7	66·0	31·9	32·9	15·8	0·5	19·1	69·4	77·7
	1st to 15th Dec. .	136	78·6	74·8	34·6	59·7	22·8	0	8·8	87·5	74·8
2. Tahsil Gohana . .	1st to 15th Aug. .	19	10·5	57·1	37·8	6·5	4·0	0	31·6	42·1	10·5
	1st to 15th Sept.	40	0	..	..	..	..	5·0	0	5·0	0
	16th to 30th Sept.	123	11·4	79·1	48·9	8·9	5·1	0·8	39·0	51·2	46·3
	1st to 15th Oct. .	187	29·4	68·6	26·1	20·0	7·3	3·7	33·7	66·8	36·9
	16th to 31st Oct.	197	35·5	67·3	24·4	24·1	9·0	2·0	9·1	46·7	46·7

	1st to 15th Nov. .	321	52·6	78·8	35·4	41·7	18·8	0·9	13·1	66·7	92·8
	16th to 30th Nov.	197	45·2	59·6	32·7	27·4	15·9	4·2	9·0	58·8	70·4
	1st to 15th Dec. .	47	34·0	60·0	28·9	21·9	11·9	2·1	25·5	61·7	59·6
3. Tahsil Sonipat . .	1st to 15th Sept.	58	10·3	61·1	25·8	6·2	2·7	12·1	31·0	53·4	10·3
	16th to 30th Sept.	84	16·7	77·8	39·4	13·5	7·1	11·9	11·9	40·5	19·0
	1st to 15th Oct. .	179	24·6	72·2	37·6	10·2	9·2	2·8	24·6	52·0	30·7
	16th to 31st Oct.	218	30·7	67·8	27·3	20·7	8·1	2·3	7·2	40·4	48·6
	1st to 15th Nov. .	195	29·2	50·2	22·3	14·4	6·8	2·6	3·1	34·9	37·4
	16th to 31st Nov.	30	43·3	59·0	27·8	25·3	11·7	6·7	16·7	66·7	70·0
	1st to 15th Dec. .	44	22·7	40·6	21·7	19·2	4·8	0	29·5	52·3	25·0
4. Tahsil Jhajjar . .	1st to 15th Sept.	100	35·0	53·1	22·1	18·8	7·9	0	11·0	46·0	40·0
	16th to 30th Sept.	258	18·2	47·2	19·3	11·7	6·0	0	17·1	35·3	21·7
	1st to 15th Oct. .	251	27·1	72·6	29·9	20·4	9·4	2·4	19·1	48·6	35·9
	16th to 31st Oct.	183	34·3	61·7	26·8	21·3	9·3	3·0	14·6	52·0	45·5
	1st to 15th Nov. .	80	55·0	76·2	26·6	42·2	13·4	1·3	37·5	93·8	140·0
Total for District . .	1st to 15th Aug. .	19	10·5	57·1	37·8	6·5	4·0	0	31·6	42·1	10·5
	1st to 15th Sept.	597	18·9	63·4	36·2	12·9	7·9	1·8	19·2	40·0	27·6
	16th to 30th Sept.	944	14·1	61·8	32·1	9·7	5·2	2·0	21·8	38·0	20·7
	1st to 15th Oct. .	1,193	25·7	70·6	30·6	21·8	8·3	2·4	24·6	52·8	33·6
	16th to 31st Oct.	1,201	31·9	69·6	29·3	22·2	9·4	1·5	17·5	51·1	43·7
	1st to 15th Nov. .	826	46·7	73·2	32·5	34·1	15·4	1·8	15·7	64·2	82·4
	16th to 30th Nov.	579	47·8	57·2	32·2	30·7	15·6	2·2	15·5	65·6	74·7
	1st to 15th Dec. .	227	58·5	70·6	32·9	42·6	19·6	0·4	16·2	75·3	105·7
IV. District Gurgaon.											
1. Tahsil Gurgaon . .	16th to 30th Sept.	261	22·6	80·3	32·5	18·1	7·7	1·1	29·1	52·9	32·6
	1st to 15th Oct.	..	..	..	..	..	..	..	..	..	..
	16th to 31st Oct.	90	18·9	82·4	20·3	15·1	3·7	3·3	13·3	35·6	27·4
	1st to 15th Nov.	165	52·1	63·5	32·6	33·3	17·7	1·2	20·6	73·9	98·3

TABLE V—*contd.*

Seasonal variation in the intensity of Bollworm attack in green bolls of Desi *cottons, in the South-eastern Punjab, during August to December, 1924 and 1925*—contd.

District and Tahsil	Date of taking sample (year 1924 and 1925)	Number of bolls examined	Pink-Bollworm					Per cent. bolls attacked by Spotted Bollworms	Per cent. bolls showing *sims* of Bollworm attack	Total of columns 4, 9 & 10	Number of Pink-Bollworms found per 100 bolls examined
			Per cent. bolls attacked	Per cent. loculi attacked	Per cent. seeds attacked	Absolute per cent. of attacked loculi	Absolute per cent. of attacked seeds				
1	2	3	4	5	6	7	8	9	10	11	12
IV. DISTRICT GURGAON—*contd.*											
1. Tahsil Gurgaon—*contd.*	16th to 30th Nov.	100	77·0	77·0	44·6	58·7	34·7	0	12·0	89·0	227·0
	1st to 15th Dec.	225	65·8	65·2	31·6	43·2	20·7	0	10·2	76·0	133·3
	16th to 31st Dec.	57	78·9	69·8	40·0	55·9	30·9	0	5·3	84·2	96·5
2. Tahsil Nuh . .	16th to 30th Sept.	116	37·1	63·8	32·4	23·2	13·2	0	23·3	60·3	47·4
	1st to 15th Oct.	173	14·5	32·1	31·0	12·4	4·9	2·9	32·4	49·7	36·4
	16th to 31st Oct.	161	31·1	75·7	31·7	22·5	10·2	0·6	18·6	50·3	59·0
	1st to 15th Nov.	341	26·1	61·8	24·5	16·0	6·3	3·5	13·5	43·1	53·1
	16th to 30th Nov.	233	24·5	84·9	33·0	23·2	8·6	0·9	9·4	34·8	31·8
	1st to 15th Dec.	216	56·9	79·0	36·7	43·5	20·4	3·2	6·5	66·7	122·2
	16th to 31st Dec.	40	62·5	52·6	26·9	32·0	16·0	22·5	12·5	97·5	92·5
3. Tahsil Ferozpur-jharka.	1st to 15th Oct.	231	18·6	61·8	32·6	11·5	5·4	0·9	14·3	33·8	31·2
	16th to 31st Oct.	277	20·9	79·5	34·8	16·6	7·2	2·5	16·2	39·7	37·6
	1st to 15th Nov.	268	49·6	84·1	56·2	41·9	29·0	2·2	21·6	73·5	115·0
	16th to 30th Nov.	85	72·9	73·5	38·7	57·3	29·1	2·4	11·8	87·1	172·9
	1st to 15th Dec.	100	70·0	74·8	29·6	52·1	20·1	0	15·0	85·0	176·0
	16th to 31st Dec.	82	90·2	72·4	28·2	65·4	25·6	1·2	8·5	100·0	146·3

4. Tahsil Rewari . .	16th to 30th Sept.	DF	1·1	100·0	19·0	1·1	0·2	0	2·2	3·3	2·2
	1st to 15th Oct.	100	11·0	92·1	35·9	9·8	3·8	3·0	40·0	54·0	20·0
	16th to 31st Oct.	113	1·8	28·6	18·5	0·6	0·2	0	0	1·8	1·8
	1st to 15th Nov.	175	34·3	79·6	31·4	27·1	11·2	4·6	19·4	58·3	60·0
	16th to 30th Nov.	124	4·8	42·1	23·0	2·1	1·1	3·2	21·0	29·0	5·6
	1st to 15th Dec.	189	13·8	55·4	32·0	7·6	4·2	2·1	19·0	34·9	17·5
5. Tahsil Palwal . .	16th to 30th Sept.	35	11·4	41·7	30·0	4·5	3·3	0	14·3	25·7	11·4
	1st to 15th Oct.	98	11·2	51·5	20·7	5·6	2·7	3·1	19·4	33·7	14·2
	16th to 31st Oct.	251	19·9	73·4	45·5	14·3	8·3	1·9	27·9	49·8	33·9
	1st to 15th Nov.	284	25·4	55·6	31·2	14·3	7·8	2·1	16·9	44·4	35·6
	16th to 30th Nov.	297	29·6	64·8	32·6	18·8	9·6	0·3	10·1	40·1	54·5
	1st to 15th Dec.	42	26·2	54·3	32·4	14·6	9·1	0	21·4	47·6	57·1
	16th to 31st Dec.	67	7·5	60·0	29·9	4·3	2·1	0	6·0	13·4	8·9
Total for the District .	16th to 30th Sept.	504	21·0	72·2	32·3	15·3	7·5	0·6	21·8	43·6	29·0
	1st to 15th Oct.	602	15·0	70·1	30·9	10·5	4·6	2·2	24·6	41·7	28·1
	16th to 31st Oct.	892	19·8	69·2	35·3	14·8	6·8	1·8	17·6	39·2	34·8
	1st to 15th Nov.	1,233	35·7	87·6	37·7	25·0	13·7	2·8	17·8	56·3	66·5
	16th to 30th Nov.	849	34·2	74·8	37·3	26·0	13·4	1·1	11·8	47·0	72·7
	1st to 15th Dec.	772	49·0	70·3	32·9	34·1	16·1	1·4	12·6	63·0	103·2
	16th to 31st Dec.	246	60·7	70·0	31·6	41·4	18·9	4·1	7·7	72·4	88·7
V. DISTRICT KARNAL.											
1. Tahsil Karnal . .	1st to 15th Sept.	199	6·0	40·0	16·4	2·6	1·0	1·5	15·6	23·1	7·0
	16th to 30th Sept.	236	33·1	78·5	43·1	24·5	14·7	0·8	19·8	53·8	51·7
	1st to 15th Oct.	187	13·5	67·5	44·2	9·8	6·2	0	22·9	36·4	15·0
	16th to 31st Oct.	100	46·0	65·9	29·7	31·9	14·4	1·0	15·0	62·0	55·0
	1st to 15th Nov.	205	37·1	67·6	31·8	25·1	11·2	1·5	8·8	47·3	54·6
	16th to 30th Nov.	246	35·4	58·5	19·5	17·7	6·6	1·2	21·1	57·7	46·7
	1st to 15th Dec.	263	54·0	68·0	33·8	37·1	19·5	1·1	14·4	69·6	80·6
	16th to 31st Dec.	109	90·8	54·2	18·5	49·1	16·8	2·8	0	93·6	15·5

TABLE V—*concld.*

Seasonal variation in the intensity of Bollworm attack in green bolls of Desi *cottons, in the South-eastern Punjab, during August to December, 1924 and 1925*—contd.

District and Tahsil	Date of taking sample (year 1924 and 1925)	Number of boll s examined	PINK-BOLLWORM					Per cent. bolls attacked by Spotted Bollworms	Per cent. bolls showing *sigus* of Bollworm attack	Total of columns 4, 9 & 10	Number of Pink Bollworms found per 100 bolls examined
			Per cent. bolls attacked	Per cent. loculi attacked	Per cent. seeds attacked	Absolute per cent. of attacked loculi	Absolute per cent. of attacked seeds				
1	2	3	4	5	6	7	8	9	10	11	12
V. DISTRICT KARNAL—*contd.*											
2. Tahsil Thanesar .	1st to 15th Sept.	220	6·8	52·1	51·5	3·7	3·1	4·1	8·2	19·1	10·5
	16th to 30th Sept.	252	2·8	65·2	27·6	2·9	0·9	0·8	17·5	21·0	3·2
	1st to 15th Oct.	269	13·0	54·1	31·4	7·1	4·7	1·1	2·0	37·1	18·6
	16th to 31st Oct.	265	23·4	65·3	25·9	15·6	6·8	0·4	18·2	42·6	34·3
	1st to 15th Nov.	261	36·0	69·9	33·3	25·7	8·3	2·3	11·9	50·2	66·3
	16th to 30th Nov.	192	24·0	47·0	21·2	11·5	5·2	4·7	21·9	50·5	29·7
	1st to 15th Dec.	146	53·4	61·6	17·9	32·3	9·3	2·1	17·1	72·6	87·0
	16th to 31st Dec.	50	82·0	83·1	48·3	67·8	37·7	0	4·0	86·0	14·0
3. Tahsil Kaithal . .	1st to 15th Sept.	100	7·0	42·3	20·8	3·4	1·9	0	5·0	12·0	7·0
	16th to 30th Sept.	100	29·0	83·7	30·0	25·3	9·0	3·0	22·0	54·0	43·0
	1st to 15th Oct.	75	41·0	80·0	26·3	32·5	11·0	5·3	28·0	74·6	68·0
	16th to 31st Oct.	100	41·0	84·5	47·2	33·9	19·4	0	37·0	78·0	92·0
	1st to 15th Nov.	285	69·5	76·2	38·1	52·6	27·4	1·4	4·2	75·1	129·5
	16th to 30th Nov.	97	56·7	66·3	22·1	38·0	13·1	0	28·2	84·9	109·3
	1st to 15th Dec.	166	78·9	68·7	25·8	54·1	28·9	0	5·4	84·3	141·0
	16th to 31st Dec.	128	85·2	68·3	30·3	58·4	25·9	0·8	0	86·0	165·6

Tahsil Panipat . .	16th to 30th Sept.	150	37·3	68·3	40·1	24·8	14·3	1·3	26·0	64·7	70·7
	1st to 15th Oct. .	134	9·7	48·8	30·5	4·7	2·9	1·5	22·4	33·6	13·4
	16th to 31st Oct.	151	43·6	55·1	22·5	25·2	10·5	4·0	12·5	62·3	71·5
	1st to 15th Nov. .	101	54·5	61·1	34·0	33·3	17·6	1·0	17·8	73·2	88·1
	16th to 30th Nov.	259	68·0	68·4	34·1	49·7	23·5	1·9	5·4	75·3	111·6
	1st to 15th Dec. .	156	68·9	71·4	46·3	50·0	31·7	2·7	12·9	84·6	147·4
Total for District . .	1st to 15th Sept. .	519	6·6	45·6	3·0	3·2	2·0	2·4	10·4	19·5	8·5
	16th to 30th Sept.	738	23·0	53·5	52·6	17·1	9·8	1·2	20·6	44·8	37·8
	1st to 15th Oct. .	665	15·6	58·0	32·6	9·3	5·4	1·3	23·5	40·4	31·0
	16th to 31st Oct. .	616	35·4	65·6	29·3	23·7	11·3	1·3	19·6	56·4	56·2
	1st to 15th Nov. .	852	49·6	71·2	35·8	35·4	16·1	1·6	9·2	60·5	87·2
	16th to 30th Nov.	794	35·8	63·6	27·8	29·5	13·3	2·1	17·0	65·0	71·4
	1st to 15th Dec. .	671	63·4	67·9	32·2	42·8	20·5	1·5	13·6	83·6	121·1
	16th to 31st Dec.	287	86·7	65·1	14·4	56·5	23·5	1·3	0·6	88·8	155·4
Total for Region . .	1st to 15th Aug. .	737	10·0	59·4	31·2	8·4	4·4	1·7	11·3	23·0	17·2
	16th to 31st Aug.	1,328	11·0	61·9	40·2	7·3	4·5	3·9	14·6	29·6	18·6
	1st to 15th Sept. .	3,063	13·3	65·3	39·6	9·1	5·7	3·4	15·6	32·4	18·2
	16th to 30th Sept.	4,728	15·2	63·1	34·1	9·7	5·1	2·2	17·7	35·1	20·7
	1st to 15th Oct. .	6,129	18·2	67·8	32·9	12·8	6·9	1·6	17·3	37·2	25·9
	16th to 31st Oct. .	5,603	30·7	68·8	26·8	21·6	9·1	1·5	15·3	47·4	46·4
	1st to 15th Nov. .	5,974	38·1	68·9	31·7	24·8	11·6	1·7	14·0	53·8	64·8
	16th to 30th Nov.	4,411	40·1	65·6	30·3	27·1	14·0	1·4	12·5	54·1	68·2
	1st to 15th Dec. .	3,415	55·1	67·7	32·9	36·6	17·8	1·8	11·7	68·6	111·4
	16th to 31st Dec.	1,788	62·9	67·0	25·4	42·0	18·8	2·9	5·0	70·7	103·0

TABLE VI.

Number of Pink-Bollworms found per attacked green boll of Desi *cottons.*

Dates (1924)	Number of samples examined	Number of bolls examined	Percentage of bolls attacked by Pink Bollworm	PERCENTAGE OF BOLLS ATTACKED BY 1 TO 10 PINK BOLLWORMS									
				1 larva	2 larvae	3 larvae	4 larvae	5 larvae	6 larvae	7 larvae	8 larvae	9 larvae	10 larvae
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1st to 15th Aug.	3	241	2·5	100·0	..	..	..	..	..	..	..	..	..
16th to 31st Aug.	8	728	5·4	94·9	5·1	..	..	..	..	..	..	..	..
1st to 15th Sept.	14	1,218	11·5	85·0	10·7	2·1	1·4	0·7	..	..	..	..	..
16th to 30th Sept.	9	842	12·7	88·8	8·4	1·9	0·9	..	..	..	..	..	..
1st to 15th Oct.	17	2,000	14·9	83·9	13·4	2·4	0·3	..	..	..	..	..	..
16th to 31st Oct.	15	2,026	36·2	75·3	17·2	5·6	1·5	0·1	0·3	..	..	..	..
1st to 15th Nov.	20	2,311	34·4	59·1	25·5	8·9	4·0	1·4	0·5	0·1	0·4	0	0·1
16th to 30th Nov.	18	2,091	47·5	55·5	27·3	12·2	3·7	0·9	0·2	..	..	0·1	..
1st to 15th Dec.	19	1,734	66·4	46·7	32·2	12·9	5·1	2·4	0·2	0·2	0·1	0·1	..
16th to 31st Dec.	18	1,599	67·5	55·1	31·2	9·6	2·9	0·8	0·3	..	..	..	..

TABLE VII.

Number of loculi attacked and Pink-Bollworms found per attacked loculus of green boll of Desi *cottons.*

Dates (1924)	Number of samples	Number of bolls examined	Number of attacked bolls	No. of loculi damaged in attacked bolls	Percentage of attacked loculi showing						Percentage of attacked bolls with		
					signs of attack	1 larva	2 larvae	3 larvae	4 larvae	5 larvae	1 damaged loculus	2 damaged loculus	3-4 damaged loculus
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1st to 15th Aug.	3	241	6	10	40·0	60·0	..	..	..	..	50·0	33·3	16·7
16th to 31st Aug.	8	728	39	59	30·5	69·5	..	..	..	..	61·5	28·3	10·3
1st to 15th Sept.	14	1,218	140	280	39·6	59·6	0·7	..	..	..	41·5	26·4	32·1
16th to 30th Sept.	9	842	107	218	45·4	52·8	1·8	..	..	..	35·5	31·8	32·7
1st to 15th Oct.	17	2,000	298	702	50·4	48·1	1·5	..	..	..	18·4	31·9	49·7
16th to 31st Oct.	15	2,026	735	1,642	42·4	55·2	2·2	0·2	..	..	22·7	34·0	43·3
1st to 15th Nov.	20	2,311	796	1,740	30·6	61·2	7·1	0·9	0·1	0·1	18·0	41·7	40·2
16th to 30th Nov.	18	2,091	994	2,370	35·6	58·8	4·9	0·6	0·1	..	20·3	31·8	47·8
1st to 15th Dec.	19	1,731	1,151	2,584	25·9	66·1	7·1	0·8	0·1	..	22·1	36·5	41·4
16th to 31st Dec.	15	1,599	1,079	2,309	28·1	67·6	4·0	0·3	..	..	24·7	40·2	35·2

TABLE VIII.

Intensity of Pink-Bollworm attack in kapas *of different pickings of* kharif, *1924.*

Region	Variety of cotton	Picking	Weight in tolas of *kapas* examined	Number of Pink-Bollworms found	Number of Pink-Bollworms calculated per 100 tolas of *kapas*
1	2	3	4	5	6
I. South-eastern Punjab	*Desi*	Early	795	2,449	308
		Middle	876	3,198	364
		Late	971	4,817	496
		TOTAL	2,642	10,459	396
	American	Early	102	71	69
		Middle	128	152	119
		Late	106	193	183
		TOTAL	336	416	124
	TOTAL	Early	897	2,520	281
		Middle	1,007	3,345	333
		Late	1,077	5,010	465
		TOTAL	2,978	10,875	365
II. Eastern Punjab	*Desi*	Early	1,412	2,389	169
		Middle	1,362	2,063	151
		Late	1,415	2,982	211
		TOTAL	4,189	7,434	177
	American	Early	140	373	266
		Middle	200	400	200
		Late	180	396	220
		TOTAL	520	1,169	225
	TOTAL	Early	1,552	2,762	178
		Middle	1,562	2,463	158
		Late	1,595	3,378	212
		TOTAL	4,709	8,603	183
III. Central Punjab	*Desi*	Early	324	238	73
		Middle	371	269	72
		Late	354	435	124
		TOTAL	1,049	942	90

TABLE VIII—*contd.*

Intensity of Pink-Bollworm attack in kapas *of different pickings of* kharif *1924*—contd.

Region	Variety of cotton	Picking	Weight in tolas of *kapas* examined	Number of Pink Bollworms found	Number of Pink Bollworms calculated per 100 *tolas* of *kapas*
1	2	3	4	5	6
	American	Early	262	125	55
		Middle	265	137	52
		Late	160	53	33
		TOTAL	687	315	46
	TOTAL	Early	586	363	62
		Middle	636	406	64
		Late	514	488	95
		TOTAL	1,736	1,257	72
IV. Northern Area	*Desi*	Early	418	153	37
		Middle	510	114	22
		Late	426	253	59
		TOTAL	1,355	520	38
	American	Early	47	2	4
		Middle	20	0	0
		Late	20	1	5
		TOTAL	87	3	3
	TOTAL	Early	466	155	33
		Middle	530	114	21
		Late	446	254	57
		TOTAL	1,442	523	36
V. Western Punjab including the Colony areas.	*Desi*	Early	1,935	192	10
		Middle	2,177	233	11
		Late	1,955	274	14
		TOTAL	6,067	699	12
	American	Early	1,615	151	9
		Middle	1,938	188	9
		Late	1,508	152	10
		TOTAL	5,061	491	10
	TOTAL	Early	3,550	343	10
		Middle	4,115	421	10
		Late	3,463	426	12
		TOTAL	11,128	1,190	11

TABLE IX.

Pink-Bollworms resting in cotton-lint and cotton-seeds.

Kind of cotton	Material collected during *kharif* 1923 or 1924*	Number of samples examined	Total Pink-Bollworms found	Lint (Free or in silken cocoons)	NUMBER OF PINK-BOLLWORMS FOUND IN SEED-CHAMBERS				
					1-seeded	2-seeded	3-seeded	4-seeded	5-seeded
Desi	1923	118	5,262	405	487	3,148	991	191	40
	1924	627	19,869	1,516	752	12,144	3,861	1,181	415
TOTAL	..	745	25,131	1,921	1,239	15,292	4,852	1,372	455
American	1923	29	1,288	72	117	842	208	41	8
	1924	211	2,236	118	142	1,453	377	110	36
TOTAL	..	240	3,524	190	259	2,295	585	151	44
Percentage of caterpillars in lint and seed-chambers—									
Desi	1923	118	99·9	7·7	9·3	59·8	18·8	3·5	0·8
	1924	627	100	7·7	3·8	61·1	19·4	5·9	2·1
TOTAL	..	745	100	7·7	4·9	60·9	19·3	5·4	1·8
American	1923	29	100	5·6	9·1	65·4	16·1	3·2	0·6
	1924	211	99·9	5·3	6·3	65·0	16·8	4·9	1·6
TOTAL	..	240	99·9	5·4	7·3	65·1	16·6	4·3	1·2

* Samples of *kharif* 1923, were examined during January to March, 1924, and those of *kharif* 1924, during January to March, 1925.

TABLE X.

Half-monthly totals of emergences of long-cycle moths of Platyedra gossypiella, Saund., *from* kapas *of different pickings of* kharif *1923, and 1924.*

Date of emergence of moths (1924 and 1925)	Number of moths emerged from *kapas* of different pickings								Total
	Early pickings		Middle pickings		Late pickings		Mixed pickings		
	1923*	1924**	1923	1924	1923	1924	1923	1924	
April—									
1st to 15th	..	1	4	1	1	4	5	6	11
16th to 30th	2	13	10	16	3	15	15	44	59
May—									
1st to 15th	1	37	8	42	6	47	15	126	141
16th to 31st	1	49	6	86	8	51	15	186	201
June—									
1st to 15th	..	10	..	17	..	25	0	52	52
16th to 30th	..	56	9	62	4	148	13	266	271
July—									
1st to 15th	4	123	51	175	8	301	63	599	662
16th to 31st	10	69	104	80	75	253	249	402	651
August—									
1st to 15th	13	56	139	98	74	164	226	318	544
16th to 31st	2	16	17	18	4	31	23	65	88
September—									
1st to 15th	1	..	2	1	3	1	6	2	8
16th to 30th	..	..	1	..	..	..	1	..	1
October—									
1st to 15th	..	..	..	1	..	..	..	1	1
16th to 31st	..	..	..	..	..		..	..	..
November—									
1st to 15th	..	..	1	..	..	..	1	..	1
16th to 30th	..	..	..	..	..	..	..	..	..

*Samples of *kharif* 1923, were examined from 15th December, 1923, to 15th March, 1924, and the moths emerged during April, 1924, to September, 1924.
**Samples of *kharif*, 1924, were examined from 1st January, 1925, to 31st March, 1925, and the moths emerged during April, 1925, to November, 1925.

TABLE X—*contd.*

Half-monthly totals of emergences of long-cycle moths of Platyedra gossypiella, Saund, *from* kapas *of different pickings of* kharif *1923, and 1924*—contd.

Date of emergence of moths (1924 and 1925)	NUMBER OF MOTHS EMERGED FROM *kapas* OF DIFFERENT PICKINGS								TOTAL
	Early pickings		Middle pickings		Late pickings		Mixed pickings		
	1923*	1924**	1923	1924	1923	1924	1923	1924	
Calculated as 1,000 emergences.									
April—									
1st to 15th	..	2	10	2	15	3	8	3	4
16th to 30th	59	30	24	28	16	15	24	21	22
May—									
1st to 15th	29	86	18	70	32	46	24	61	52
16th to 31st	29	116	16	143	43	49	24	90	75
June—									
1st to 15th	..	2	..	28	..	24	..	25	20
16th to 30th	..	23	22	104	21	142	21	129	104
July—									
1st to 15th	118	130	125	293	43	290	100	290	245
16th to 31st	294	285	398	134	403	243	394	195	241
August—									
1st to 15th	382	160	337	164	398	158	358	154	209
16th to 31st	59	130	41	30	21	30	36	31	33
September—									
1st to 15th	30	36	5	2	18	..	9	1	4
16th to 30th	..	..	2	..	..	..	2	..	..
October—									
1st to 15th	..	..	..		..	..	..	..	..
16th to 31st	..	..	..	..	..	..	..	..	..
November—									
1st to 15th	..	..	..	2	..	..	..	..	.
16th to 30th	..	..	..	..	..	..	..	..	..

* Samples of *kharif* 1923, examined from 15th December, 1923, to 15th March, 1924, and the moths emerged during April, 1924, to September, 1924.
**Samples of *kharif*, 1924, were examined from 1st January, 1925, to 31st March, 1925, and the moths emerged during April, 1925, to November, 1925.

TABLE XI.

Emergence of long-cycle moths from caterpillars resting in cotton-lint and seeds.

Description	Number of Pink-Bollworms kept under observation (Approximate)	NUMBER OF MOTHS EMERGED												Total	Percentage of Pink-Bollworms which reached the moth stage
		April		May		June		July		August		September			
		1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30		
I. Pink-Bollworms resting in cotton-lint.	1,113	4	12	13	9	..	..	3	13	6	1	..	..	61	5·4
II. Pink-Bollworms resting in cotton-seeds—															
(*a*) In 1 or 2 seeded resting-chambers.	2,633	1	2	4	3	3	10	42	169	164	18	4	1	421	15·9
(*b*) In 3 to 5 seeded resting-chambers.	626	0	1	2	2	0	4	15	63	52	5	3	1	148	23·6
TOTAL	3,259	1	3	6	5	3	14	57	232	216	23	7	2	569	17·4
Calculated as 1,000 emergences.															
I. Pink-Bollworms resting in cotton lint.	..	66	197	213	147	0	0	49	213	98	16	0	0	999	..
II. Pink-Bollworms resting in cotton seeds—															
(*a*) In 1 or 2 seeded resting-chambers.	..	2	5	9	7	7	24	100	402	389	43	9	2	999	..
(*b*) In 3 to 5 seeded resting-chambers.	..	0	7	13	13	0	27	101	426	351	34	20	7	999	..
TOTAL	..	2	5	11	10	5	25	100	408	380	40	12	4	1,002	..

TABLE XII.

Half-monthly totals of emergences of moths (short and long-cycle) of Platyedra gossypiella, Saund, *from green bolls of* kharif, *1924.*

Date of emergence of moths (1924 and 1925)	DATE OF TAKING SAMPLE (YEAR 1924)																TOTAL	EMERGENCE OF LONG-CYCLE MOTHS CALCULATED AS 1,000	
	September				October				November				December						
	1-7	8-15	16-23	24-30	1-7	8-15	16-23	24-31	1-7	8-15	16-23	24-30	1-7	8-15	16-23	24-31			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
September—																			
1st to 15th	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
16th to 30th	26	1	51	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
October—																			
1st to 15th	..	12	30	33	9	..	..	..	..	..	..	..	..	..	..	..	..	..	
16th to 31st	..	..	6	43	52	38	1	..	..	..	..	..	..	..	..	..	..	..	
November—																			
1st to 15th	..	..	..	..	..	78	10	8	..	..	..	..	..	..	..	..	..	..	
16th to 30th	..	..	..	..	1	4	13	..	..	..	..	..	..	..	..	..	..	..	
December—																			
1st to 15th	..	..	..	..	..	14	21	12	9	..	2	..	..	..	..	..	..	..	
16th to 31st	..	..	..	..	..	..	3	7	6	6	..	..	..	..	..	..	..	..	
January—																			
1st to 15th	..	..	..	..	..	..	..	5	20	4	..	..	..	..	..	..	..	..	
16th to 31st	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	
February—																			
1st to 15th	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
16th to 29th	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	

March—																		
1st to 15th	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
16th to 31st	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	2	4	3
April—																		
1st to 15th	..	..	..	..	..	..	..	9	10	4	13	7	14	5	14	2	78	54
16th to 30th	..	..	..	..	..	2	..	10	12	14	14	5	27	9	24	2	117	81
May—																		
1st to 15th	..	..	..	..	..	..	1	13	13	13	13	10	28	13	27	3	135	93
16th to 31st	..	..	..	..	..	..	..	24	8	19	7	3	41	23	23	12	161	111
June—																		
1st to 15th	..	..	..	..	..	..	..	16	10	11	12	8	10	9	9	1	86	59
16th to 30th	..	..	..	..	..	..	..	20	16	23	43	22	44	35	23	7	233	161
July—																		
1st to 15th	..	..	..	..	..	..	..	31	23	37	44	33	93	46	40	14	361	250
16th to 31st	..	..	..	..	1	1	7	6	12	22	10	86	9	34	8	196	135	
August—																		
1st to 15th	..	..	..	..	..	..	..	5	1	7	5	6	37	1	9	1	73	51
16th to 31st	..	..	..	..	..	1	1	..	..	..	..	1	..	..	..	..	3	2
Short-cycle moths (September 1924 to January 1925).	30	13	87	76	62	134	48	32	35	12	2	..	..	..	..	..	..	..
Long-cycle moths (March 1925 to August 1925).	..	..	..	..	..	4	3	135	99	140	173	105	383	150	202	53	..	..
Calculated as 100 emergences from each week collection—																		
Long-cycle moths	100	100	100	100	100	97	94	19	26	8	1	..	..	..	..	..	..	..
Short-cycle moths	..	..	..	..	..	3	6	81	74	92	99	100	100	100	100	100	..	..

TABLE XIII.

Resting period of Pink-Bollworm in green bolls.

Number of weeks for which Pink-Bollworm rested	DATE OF TAKING SAMPLE (1924)											TOTAL
	OCTOBER			NOVEMBER				DECEMBER				
	8-15	16-23	24-31	1-7	8-15	16-23	24-30	1-7	8-15	16-23	24-31	
12	..	..	..	..	..	..	..	..	..	..	2	2
13	..	..	..	..	..	..	..	..	..	2	1	3
14	..	..	..	..	..	..	..	..	..	9	1	10
15	..	..	..	..	..	..	..	..	4	5	1	10
16	..	..	..	..	..	..	..	10	1	9	1	21
17	..	..	..	..	..	..	4	4	3	15	..	26
18	..	..	..	..	..	9	3	14	6	12	3	47
19	..	..	..	..	4	4	3	13	3	15	5	47
20	..	..	..	10	..	10	2	3	10	20	7	62
21	..	..	4	..	7	4	3	25	13	3	1	60
22	..	..	5	8	7	5	7	27	10	..	..	69
23	..	..	4	4	4	8	3	14	2	9	5	53
24	..	..	6	1	9	7	..	3	7	17	2	52
25	..	..	1	12	13	..	..	7	13	6	5	57
26	..	..	12	8	6	..	8	19	22	19	9	103
27	1	..	17	..	..	12	5	25	21	21	2	104
28	1	..	7	1	11	15	17	15	25	13	6	111
29	..	1	1	9	11	28	17	78	4	21	1	161
30	..	..	15	8	12	25	16	26	5	6	1	114
31	..	..	4	8	21	19	7	60	1	3	..	123
32	..	..	16	11	16	11	3	26	..	..	..	83
33	..	..	16	12	6	11	6	11	..	..	..	62
34	..	..	15	3	6	3	..	..	..	..	..	31
35	..	..	3	3	1	2	1	..	..	..	..	10
36	..	..	4	1	6	..	..	..	..	..	..	11
37	1	..	1	..	..	..	..	..	..	..	..	2
38	..	1	4	..	..	..	..	..	..	..	..	5
39	..	1	..	..	..	..	..	..	..	..	..	1
40	1	..	..	..	..	..	..	..	..	..	..	1

M&IPO—M—IV-2-69—10-6-68—750.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

TO BE HAD FROM

THE MANAGER, GOVERNMENT OF INDIA CENTRAL PUBLICATION BRANCH, IMPERIAL SECRETARIAT BUILDING, 3, GOVERNMENT PLACE, WEST, CALCUTTA;

THE OFFICE OF THE AGRICULTURAL ADVISER TO THE GOVERNMENT OF INDIA, PUSA, BIHAR;

AND

ALL AGENTS FOR SALE OF GOVERNMENT PUBLICATIONS.

A complete list of the publications of the Imperial Department of Agriculture in India can be obtained on application from the above-mentioned.

These publications are:—

1. The *Agricultural Journal of India*. A Journal dealing with subjects connected with agricultural economics, field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, farm implements, and other agricultural matters in India. Illustrations, including coloured plates, form a prominent feature of the Journal. It is edited by the Agricultural Adviser to the Government of India, and is issued once every two months or six times a year. *Annual Subscription*, Rs. 6 or 9*s.* 6*d.*, including postage. Single copy, Re. 1-8 or 2*s.*
2. The *Journal of the Central Bureau for Animal Husbandry and Dairying in India*. A quarterly dealing with cattle breeding, dairying, cultivation and storage of fodder crops, animal nutrition, and other aspects of animal husbandry. It is edited by the Agricultural Adviser to the Government of India. *Annual Subscription*, Rs. 2-8. Single copy, As. 10.
3. Scientific Reports of the Agricultural Research Institute, Pusa.
4. Annual Review of Agricultural Operations in India.
5. Proceedings of the Board of Agriculture in India.
6. Proceedings of Sectional Meetings of the Board of Agriculture.
7. Memoirs of the Imperial Department of Agriculture in India.
   - (*a*) Botanical Series.
   - (*b*) Chemical Series.
   - (*c*) Entomological Series.
   - (*d*) Bacteriological Series.
   - (*e*) Veterinary Series.
8. Bulletins issued by the Agricultural Research Institute, Pusa.
9. Books.

The following are the publications of the last two years:—

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, the Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), for the year 1925-26. Price, Rs. 2-8 or 4*s.* 6*d.*

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), for the year 1926-27. Price, Re. 1-14 or 3*s.* 3*d.*

Review of Agricultural Operations in India, 1924-25. Price, Rs. 2-2 or 4*s.*

Review of Agricultural Operations in India, 1925-26. Price, Rs. 2-6 or 4*s.* 3*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on 7th December, 1925, and following days (with appendices). Price, Re. 1-14 or 3*s.* 3*d.*

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

Botanical Series

Vol. XIV, No. I. A Study of Some Indian Grasses and Grasslands, by W. Burns, D.Sc., L. B. Kulkarni, M.Ag., and S. R. Goldbole, B.Sc., B.Ag. Price, As. 12 or 1*s.* 3*d.*

Vol. XIV, No. II. Studies in Gujarat Cottons, Part III. The Wagad Cotton of Upper Gujarat, Kathiawad and Kutch, by Maganlal L. Patel, M.Ag., and D. P. Mankad. Price, Re. 1-4 or 2*s.* 3*d.*

Vol. XIV, No. III. Sugarcane Breeding—Indications of Inheritance, by Rao Sahib T. S. Venkatraman, B.A. Price, As. 8 or 10*d.*

Vol. XIV, No. IV. Studies in Gujarat Cottons, Part IV: Hybrids between Broach-deshi and Goghari varieties of *Gossypium herbaceum*, by M. L. Patel, M.Ag., and S. J. Patel, B.Ag. Price, As. 14 or 1*s.* 6*d.*

Vol. XIV, No. V. The Indigenous Cotton Types of Burma, by T. D. Stock, B.Sc., D.I.C., A.R.C.S. Price, As. 9 or 10*d.*

Vol. XIV, No. VI. A Study of *Fusaria* common to cotton plants and cotton soils in the Central Provinces, by Jiwan Singh, M. Sc. Price, As. 5 or 6*d.*

Vol. XIV, No. VII. The *Kolamba* Rice of the North Konkan and its Improvement by Selection, by R. K. Bhide and S. G. Bhalerao, B.Ag. Price, Re. 1-4 or 2*s.*

Vol. XIV, No. VIII. *Pennisetum typhoideum*: Studies on the Bajri crop. 1. The Morphology of *Pennisetum typhoideum*, by S. V Godbole, M.Sc., B.Ag. Price, As. 12 or 1*s.* 3*d.*

Vol. XV, No. I. Studies in Khandesh Cotton, Part I, by S. H. Prayag, M.Ag. Price, Re. 1-4 or 2*s.* 3*d.*

Vol. XV, No. II. The Indian Types of *Lathyrus sativus* L. (Khesari, Lakh, Lang, Teora), by Gabrielle L. C. Howard, M.A., and K. S. Abdur Rahman Khan. Price, Re. 1-8 or 2*s.* 6*d.*

Vol. XV, No. III. Fruit-Rot Disease of Cultivated Cucurbitaceæ caused by *Phythium aphanidermatum* (Eds.) Fitz., by M. Mitra, M.Sc., F.L.S., and L. S. Subramaniam, F.L.S. Price, As. 6 or 8*d.*

Vol. XV, No. IV. Colour Inheritance in Rice, by S. K. Mitra, M.S., Ph.D., and S. N. Gupta and P. M. Ganguli. Price, As. 6 or 8*d.*

Vol. XV, No. V. *Asterina* spp. from India determined by Dr. Ruth Ryan and *Meliola* spp. from India and one from Malay determined by Prof. F. L. Stevens. Price, As. 4 or 5*d.*

Vol. XV, No. VI. Studies on Rice in Sind, Part I, by K. I. Thadani, M.Sc., and H. V. Durga Dutt, B.Sc. (*In the press.*)

Vol. XV, No. VII. Variability in certain economic characters particularly in seed weight and weight of lint per seed in pure strains of Broach Deshi Cotton, by Maganlal L. Patel, M.Ag., and Harold H. Mann, D.Sc. (*In the press.*)

Vol. XV, No. VIII. Studies in the Shedding of Mango Flowers and Fruits, Part I, by P. V. Wagle, M.Ag. (*In the press.*)

Vol. XVI, No. I. Studies in the *Jowars* of Gujarat; 1, The *Jowars* of the Surat District, by M. L. Patel, M.Ag., and G. B. Patel, B.Ag. (*In the press.*)

Chemical Series

Vol. VIII, No. V. Nitrogen Recuperation in the Soils of the Bombay Deccan, Part I, by D. L. Sahasrabuddhe, M.Ag., M.Sc., and J. A. Daji, B.Ag., B.Sc. Price, As. 4 or 5*d.*

Vol. VIII, No. VI. The Determination of available Phosphoric Acid of Calcareous Soils, by Surendralal Das, M.Sc. Price, As. 12 or 1*s.* 3*d.*

Vol. VIII, No. VII. Deterioration of Sugarcane during its Storage by Windrowing, by Phani Bhusan Sanyal, M.Sc. Price, As. 6 or 8*d.*

Vol. VIII, No. VIII. Drainage Waters at Cawnpore, by H. N. Batham, M.A., F.I.C.S. Price, As. 10 or 1*s.*

Vol. VIII, No. IX. Nutrients required for Milk Production with Indian Foodstuffs, by F. J. Warth, M.Sc., Labh Singh, L.Ag., B.Sc. (Ag.), and S. M. Husain, B.Sc. Price, As. 14 or 1*s.* 6*d.*

Vol. VIII, No. X. Silage Experiments at Nagpur, by Harold E. Annett, D.Sc., F.I.C., M.S.E.A.C., and A. R. Padmanabha Aiyar, B.A. Price, As. 10 or 1*s.*

Vol. VIII, No. XI. Nutrients required for Growth Production with Indian Foodstuffs, by F. J. Warth, M.Sc., and Ijaz Ahmad, B.Sc. (Ag.) Price, As. 3 or 4*d.*

Vol. VIII, No. XII. A Study of Absorption of Moisture by Soils by J. Sen, M.A., Ph.D., and Bhailal M. Amin, B.A. Price, As. 6 or 9*d.*

Vol. IX, No. I. The Selection of Burma Beans (*Phaseolus lunatus*) for Low Prussic Acid Content, by J. Charlton, M.Sc., F.I.C. Price, As. 10 or 1*s.*

Vol. IX, No. II. Bangalore Maintenance Experiments, First Series, by F. J. Warth, M.Sc. Price, As. 11 or 1*s.* 2*d.*

Chemical Series—*contd.*

Vol. IX, No. III. Some Digestibility Trials on Indian Feeding Stuffs II, by P. E. LANDER, M.A., D.SC., A.I.C., and PANDIT LAL CHAND DHARMANI, L.AG., B.SC. (AG.). Price, As. 10 or 1*s.*

Vol. IX, No. IV. The Effect of Manuring a Crop on the Vegetative and Reproductive Capacity of the Seed, by B. VISWANATH, F.I.C., and M. SUBIANARAYANA, B.SC. Price, As. 14 or 1*s.* 6*d.*

Vol. IX, No. V. Experiments on the feeding of Sorghum Silage and Concentrate to Scindi Calves, by F. J. WARTH, M. SC., and SHARI KANT MISRA. Price, As. 9 or 10*d.*

Vol. IX, No. VI. Losses and gains of Nitrogen in an Indian Soil studied in relation to the seasonal composition of well waters, and the bearings of the results on the alleged deterioration of soil fertility, by HAROLD E. ANNETT, D.SC. (Lond.), F.I.C. M.S.E.A.C., and A. R. PADMANABHA AIYER and RAM NARAYAN KAYASTH. (*In the press.*)

Vol. IX, No. VII. Some Digestibility Trials on Indian Feeding Stuffs, Part III: Some Punjab Hays, by P. E. LANDER, D.SC., A.I.C., and PANDIT LAL CHAND DHARMANI, L.AG., B.SC. (AGRI.). (*In the press.*)

Vol. IX, No. VIII. The determination of the Electrical Conductivity of the aqueous extract of Soil as a rapid means of detecting its probable Fertility, by ASHUTOSH SEN, M.SC. (*In the press.*)

Entomological Series

Vol. IX, No. IV. The Red Pumpkin Beetle, *Aulacophora abdominalis*, Fb. (Coleoptera Chrysomelidæ) and its Control; with a short Note on *A. atripennis* Fb., by M. AFZAL HUSAIN, M.SC., M.A., and S. ABDULLAH SHAH, L.AG. Price, Re. 1 or 1*s.* 9*d.*

Vol. IX, No. V. Experiments on the Transmission of Rinderpest by means of Insects, by S. K. SEN, B.SC., F.E.S. Price, Rs. 2-4 or 4*s.* 2*d.*

Vol. IX, No. VI. Studies on Indian Thysanoptera, by DR. H. H. KARNY. Price, Re. 1-8 or 2*s.* 6*d.*

Vol. IX, Nos. VII—IX. New Species of Indian Gall Midges (*Itonididæ*), by Dr. E. P. FELT; New Indian Geometridæ, by LEWIS B. PROUT, F.E.S.; Description of *Laspeyresia stirpicola*, n. sp. (Lepidoptera), by E. MEYRICK, F.R.S., with a short Note on the Life-history and Status, by C. S. MISRA, B.A. Price, As. 5 or 6*d.*

Vol. X, Nos. I & II. Four New Indian Gall Midges, by Dr. E. P. FELT; The Citrus Psylla (*Diaphorina citri*, Kuw.), by M. AFZAL HUSAIN, M.SC., M.A. Price, Re. 1-2 or 2*s.*

Vol. X, No. III. Braconidæ Vipioninæ of South India, by T. V. RAMAKRISHNA AYYAR, B.A., F.E.S., F.Z.S. Price, As. 14 or 1*s.* 3*d.*

Vol. X, No. IV. Some New Indian Miridæ (*Capsidæ*), by E. BALLARD, B.A., F.E.S. Price, As. 6 or 8*d.*

Vol. X, No. V. The Use of Hydrocyanic Acid Gas for the Fumigation of American Cotton on import into India. Experiments on its lethal power for the Mexican Bollweevil (*Anthonomus grandis*) and for the Grain-weevil (*Sitophilus oryzæ*); on the extent to which it is absorbed by Cotton and Jute respectively; and on a practical method for satisfactory fumigation on a large scale, by A. JAMES TURNER, M.A., B.SC., and D. L. SEN, M.SC. TECH., M.SC., with a Foreword by B. C. BURT, M.B.E., B.SC. Price, Rs. 2 or 3*s.* 9*d.*

Vol. X, No. VI. Studies on *Platyedra gossypiella*, Saunders, (Pink Bollworm) in the Punjab by SOHAN SINGH BINDRA, M.SC. Price, Rs. 1-34 or 2*s.* 3*d.*

Bacteriological Series

Vol. II, No. II. A Bacterial Soft Rot of Garden Poppy, by C. S. RAM AYYAR, B.A. Price, As. 5 or 6*d.*

Veterinary Series

Vol. III, No. VI. Nasal Granuloma in Cattle, by V. KRISHNAMURTI AYYAR, I.V.S. Price, Re. 1 or 1*s.* 6*d.*

Vol. III, No. VII. Experiments on the treatment of Hookworm Infection in Dogs, by AMARNATH GULATI, M.SC. (Punjab). Price, As. 11 or 1*s.* 3*d.*

Veterinary Series—*contd.*

Vol. III, Nos. VIII & IX. On the occurrence of a Lung Fluke *Paragonimus edwardsi*, n. sp. in a Palm Civet (*Paradoxurus grayi*) in Kumaon Hills, by AMARNATH GULATI, M.SC. (Punjab); On the occurrence of *Isospora* and *Balantidium* in Cattle by H. COOPER, M.R.C.V.S., and AMARNATH GULATI, M.SC. (Punjab). Price, As. 4 or 6*d*.

Vol. IV, No. I. The Chemotherapy of Surra (*Trypanosoma Evansi* Infections) of Horses and Cattle in India, by J. T. EDWARDS, D.SC., M.R.C.V.S. Price, Rs. 4-2 or 7*s*.

Vol. IV, No. II. Studies in Bovine Lymphangitis, by V. KRISHNAMURTI AYYAR. Price, Re. 1-3 or 2*s*.

Vol. IV, No. III. Trypanblue and certain dithio-aniline derivatives: some clinical observations upon their efficacy in the treatment of Piroplasmosis and other affections in the Central Provinces, by MAJOR R. F. STIRLING, F.R.C.V.S., D.V.S.M., F.Z.S. Price, As. 3 or 4*d*.

Bulletins issued by the Agricultural Research Institute, Pusa

No. 164. Standard Methods of Analysis of Fertilizers, by J. SUN, M.A., PH.D. Price, As. 4 or 6*d*.

No. 165. List of Publications on Indian Entomology, 1925 (compiled by the Imperial Entomologist, and the offg. Imperial Entomologist, Pusa). Price, As. 12 or 1*s*. 3*d*.

No. 166. Sampling for Rice Yield in Bihar and Orissa, by J. A. HUBBACK, I.C.S. Price, As. 7 or 9*d*.

No. 167. A Scheme of Classification of the Varieties of Rice Found in Burma, by R. A. BEALE. Price, As. 6 or 8*d*.

No. 168. List of Publications on Indian Entomology, 1926 (compiled by the Offg. Imperial Entomologist and the Imperial Entomologist). Price, As. 10 or 1*s*.

No. 169. The Stem-bleeding Disease of Arecanut (*Areca catechu*) caused by *Thielaviopsis paradoxa* Von Hon., by S. SUNDARARAMAN, M.A., C. KRISHNAN NAYAR and T. S. RAMAKRISHNAN, M.A. Price, As. 9 or 1*s*.

No. 170. Seasonal Variations in the Germ Content of Milk at Pusa, by J. H. WALTON, M.A., M.SC. Price, As 6 or 8*d*.

No. 171. The Improvement of Indian Wheat. A Brief Summary of the Investigations carried out at Pusa from 1905 to 1924, including an account of the new Pusa Hybrids, by ALBERT HOWARD, C.I.E., M.A., and GABRIELLE L. C. HOWARD, M.A. Price, As. 8 or 10*d*.

No. 172. The Mechanical Analysis of Tropical Soils, by J. CHARLTON, M.SC., F.I.C. Price, As. 3 or 4*d*.

No. 173. Occurrence of Trichomonad Flagellates in the blood stream of Fowls, by HUGH COOPER, M.R.C.V.S., and AMAR NATH GULATI, M.SC. Price, As. 3 or 4*d*.

No. 174. Unit System for Farm Buildings, by G. S. HENDERSON, N.D.A., N.D.D. Price, As. 5 or 6*d*.

No. 175. A Comparative Study of the methods of preparation of the Soil for the Mechanical Analysis, with a Note on the Pipette Method, by AMAR NATH PURI, PH.D., and B. M. AMIN, B.A. (*In the press.*)

No. 176. A Method of increasing the Manurial Value of *Mahua* Cake, by N. D. VYAS, L.AG. (*In the press.*)

Books

Wheat in India, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S., and GABRIELLE L. C. HOWARD, M.A. Price, Rs. 5 or 7*s*. 6*d*.

A Description of the Imperial Bacteriological Laboratory, Muktesar; Its Work and Products, by MAJOR J. D. E. HOLMES, M.A., D.SC., M.R.C.V.S. Price, As. 8 or 9*d*.

Agriculture in India, by JAMES MACKENNA, M.A., I.C.S. Price, As. 4 or 5*d*.

Some Diseases of Cattle in India. A Handbook for Stock-owners. (Revised) Price, Re. 1-4 or 2*s*.

Report on the Diseases of Silkworms in India, by A. PRINGLE JAMESON, D.SC. Price, Rs. 3.

Notice

All new publications are included in the above list and are regularly posted to all on the mailing list as soon as issued. Unless complaints of non-receipt of any publication are received by the Manager, Government of India Central Publication Branch, Imperial Secretariat Building, 3, Government Place, West, Calcutta, within six months of the date of issue, duplicate copies can be supplied only on payment of cost and postage.